THE SPIDERS (ARANEIDA) OF HAZEN CAMP 81°49'N, 71°18'W*

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About 20,600 spiders (Araneida) from Hazen Camp (81°49'N, 71°18'W), Ellesmere Island, Northwest Territories, Canada, were examined. These represent four families and thirteen species: Dictynidae, Dictyna borealis *Pickard-Cambridge; Lycosidae,* Pardosa glacialis *(Thorell),* Tarentula exasperans *Pickard-Cambridge; Linyphidae,* Collinsia spetsbergensis *(Thorell),* Collinsia thulensis *(Jackson),* Cornicularia karpinskii *(Pickard-Cambridge),* Erigone psychrophila *Thorell,* Hilaira vexatrix *(Pickard-Cambridge),* Meioneta nigripes *(Simon),* Minyriolus pampia *Chamberlin,* Savignya barbata *(Koch),* Typhochraestus latithorax *(Strand), and Thomisidae,* Xysticus deichmanni *Soerensen. The known distribution of each species is listed. Detailed descriptions of the rare species and drawings of the structures useful for identification of each species and sex are given. An analysis of the seasonal occurrence of the adults of each species in 1964 and partial results from 1963, showed that all the species were active during the first three weeks following the first day of spring melt, namely June 10 to June 30. Nine species inhabited the humid terrestrial environment, one was present in all environments, and three only in arid environments.*

Escape orientation of Pardosa glacialis *was analyzed in relation to the sun and the observer; reasons for the escape directions are given. The species* Pardosa glacialis *and* Xysticus deichmanni *were found to be parasitized by* Hexamermis *sp. (Nematoda, Mermithidae).*

The zoogeographical data indicate that there were one or more refugia at or near the northern end of Ellesmere Island during the Wisconsin glaciation and perhaps for the entire Pliestocene epoch. Some of the extant insects and spiders were present in these refugia though most, especially spiders restricted to night shadow areas, have probably immigrated since from more southern localities.

The spiders (Araneida) from the high Nearctic Region are poorly known in every respect - distribution, number of species, natural history, and past history. Previous to this study, the largest single collection of spiders from such a northern location as Hazen Camp (81°49'N, 71°18'W), Ellesmere Island, Northwest Territories, Canada, was the collection made by the Danish Peary Land Expedition of 1947-50, which collected 103 specimens of eight endemic species and one obviously introduced species (Braendegaard 1960). In the winter of 1898-99, the Second Expedition of the "Fram" overwintered at Rice Strait, between Ellesmere Island and Pim Island (78°34'N, 74°45'W) (Bryce 1910), and during the warmer season of 1899, the ship's doctor (my inference) collected some 15 specimens of spiders of seven, possibly eight, species (Strand 1905, and Braendegaard 1936). Collections made by Oliver and others in 1961 and 1962 at Hazen Camp yielded a possible ten species of spiders with only five positive identifications (Oliver 1963).

The purpose of this paper is to give a detailed account of the spiders from Hazen Camp. The account includes data on the taxonomy and natural history, and theories (based on an analysis of the evidence) of the zoogeographic history of the spiders and other Arthropoda at Hazen Camp.

* An investigation associated with the programme 'Studies on Arctic Insects', Entomology Research Institute, Canada Department of Agriculture (Paper No. 24).

THE STUDY AREA

The general biology and taxonomy of spiders was studied during the summers of 1963 and 1964 at Hazen Camp, Ellesmere Island, Northwest Territories, Canada (81°49'N, 71°18'W). This is approximately 150 km southwest of Alert, and is on Lake Hazen, the largest fresh water body (78 x 11 km) in the Queen Elizabeth Islands. The study area is on the mid northwest shore of Lake Hazen and extends along the shore for about 5 km and away from the shore for about 3 km. The confines are the Snow Goose River delta, Blister Creek delta, and Mt. McGill. The range of altitudes in the study area is from 158 to 1050 m and includes the following ecological areas: clay plains and slopes, sand, gravel, alkaline clay, *Dryas* hummocks, *Dryas-Kobresia* tundra, marshes, muddy delta, gravel delta, boulder talus slopes, and springy slopes (based on Savile's personal notes of 1962, and Savile 1964, see fig. 1).

Biological work was started at Hazen Camp in 1957 and 1958 (Powell 1961), but entomological studies were not started until 1961 when Donald R. Oliver (Entomology Research Institute, Ottawa) did general collecting and studied pond ecology.

Hazen Camp was opened as an International Geophysical Year station in the late summer of 1957, and since then much information has been published about the Camp and the Lake. Christie (1962) has described the geology; Savile (1964) the ecology and vascular plants; Day (1964) and Yong (1961, *et al.* 1962) have discussed and analyzed the soil characteristics; Oliver (1963) has discussed the Insecta and Arachnida collected to the end of 1962; Jackson (1959 , 1960) has analyzed the meteorological conditions; Powell (1961) has discussed the vegetation and microclimate; Harington (1960) reported on snow and ice conditions for the winter of 1957-58; and Hattersley-Smith (1964) published a bibliography of "Operation Hazen", covering the years 1957-63.

Soil and Soil Conditions

Soil samples were collected in 1963 from the major habitats as defined by Savile (1964). The depths of permafrost at 12 sites in mid August varied from 40.6 to 99.0 cm with a mean of 73.5 cm. Yong *et al.* (1962) at a comparable period in 1962 reported a mean depth for permafrost of 51.0 cm.

Early in the season, just after the snow has melted, the ground surface becomes a quagmire, but with the sun in view continuously, it becomes firm in two to three weeks except in marsh or pond depressions. The period when the snow and ice leaves the surface of the ground will be referred to as "spring melt".

Very little of the surface soil is without frost-heave cracks. The cracks vary from 0.1 to 5 cm wide, from 1.5 to 40 cm deep, and from 10 cm to several metres long. Organic content of the soils varied from 0.3 to 19.6% with a mean of 4.1%. The pH was usually between 7.4 and 8.6. Soil temperature maxima at the surface were generally 7.5 to 16.5°C higher than air temperature maxima on sunny days, and minima were 2.5 to 5.5°C warmer than air minima on overcast days (Powell 1961). On June 6, 1964, one day before the spring melt, I recorded the following

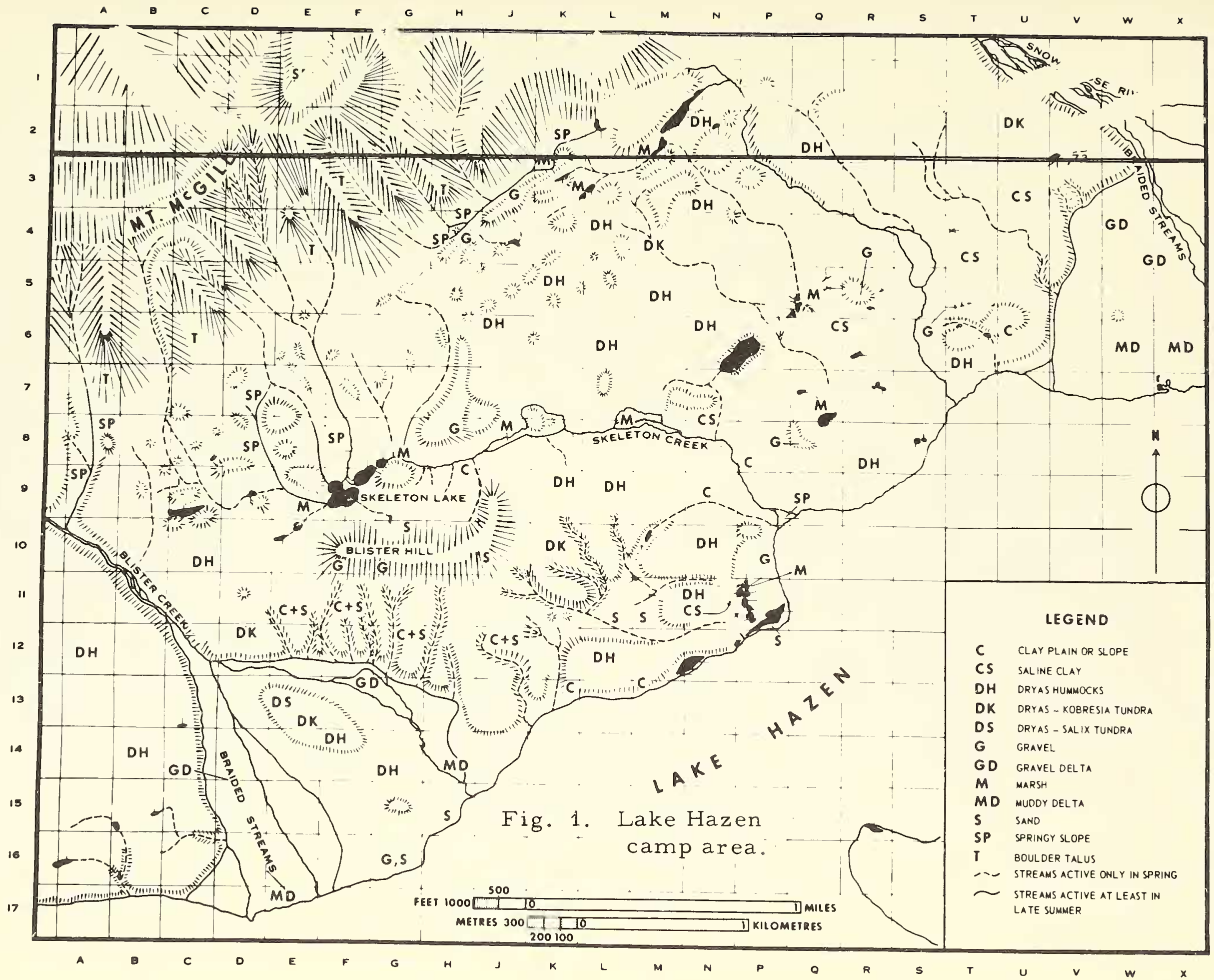


Fig. 1. Lake Hazen camp area.

temperatures in bright afternoon sun on a 20° south-facing slope: 2.5 cm above soil surface.... 2.7°C, at surface.... 6.3°C, 2.5 cm below soil surface.... 9.9°C.

In appearance, the soil is mostly sandy to sandy-clayey with moderate to sparse vegetation cover.

Vegetation

There are about 115 species of vascular plants recorded from the Lake Hazen region, but there are only a few abundant ones. These are *Salix arctica* Pall., *Dryas integrifolia* M. Vahl., *Kobresia myosuroides* (Vill.) Fiori and Paol., *Carex aquatilis* Wahlenb. var. *stans* (Drej) Boott., *Cassiope tetragona* (L.) D. Don., and in restricted areas, *Eriophorum Scheuchzeri* Hoppe, and *E. triste* (Th. Fries) Hadac and Löve. The remaining plant species are sparsely distributed throughout the study area.

Climate and Weather

Detailed records of the weather have been made for the years 1958, 1961, 1962, 1963, and 1964. The lowest winter temperature recorded by the minimum thermometer at Hazen Camp is -70.6°F (-57.0°C) during the winter of 1963-64 (personal record). Figure 2 is a graph of the cumulative day-means of Stevenson screen temperatures to date since June 1 at Hazen Camp, 100 metres from the lake shore, 1.8 m above the ground, and 161 m above sea level.

For the latitude, the summer temperatures are exceptionally high, often higher for long periods than at many nearby coastal stations. The inland position of Lake Hazen accounts for the higher temperatures. The lake is in a very stable high pressure trough region, and is in the shadow of the Garfield Range to the north and northwest.

Precipitation at Lake Hazen is very light. Jackson (1959 , p. 95) recorded 0.98 inches (2.48 cm) water equivalent during the period August 1957 to August 1958, and the station at Alert recorded 4.52 inches (12.8 cm) during the same period. Snowfall between September and May accounted for 91% of the precipitation at Lake Hazen.

Despite the low precipitation at Lake Hazen, considerable moisture is available for the plants and animals. During most summers (1964 was an exception) the melting of snow and ice from the surface is sufficiently slow that the ground surface is dry for only two weeks before the water from permafrost melting comes to the surface. As the permafrost water percolates to the surface, depressions that were full of water during the spring melt and which had dried up during the course of the summer, refill.

The wind speed averages at Lake Hazen are very low with over 76% of the yearly observations being 5 mph or less, 16% from 6-10 mph, and 8% 11 mph or over. The majority of the winds come from the northeast, along the Lake Hazen trough (Jackson 1959 , p. 125).

Relative humidities in 1962 and 1963 were read every 6 hours at 1.6 m above the ground, and give daily mean figures of 80-88% for June, and 76-80% for July and early August (Savile 1964, p. 240), but were much lower during the summer of 1964 because of continuous high winds from the southwest. The prevailing low-speed winds permitted conditions

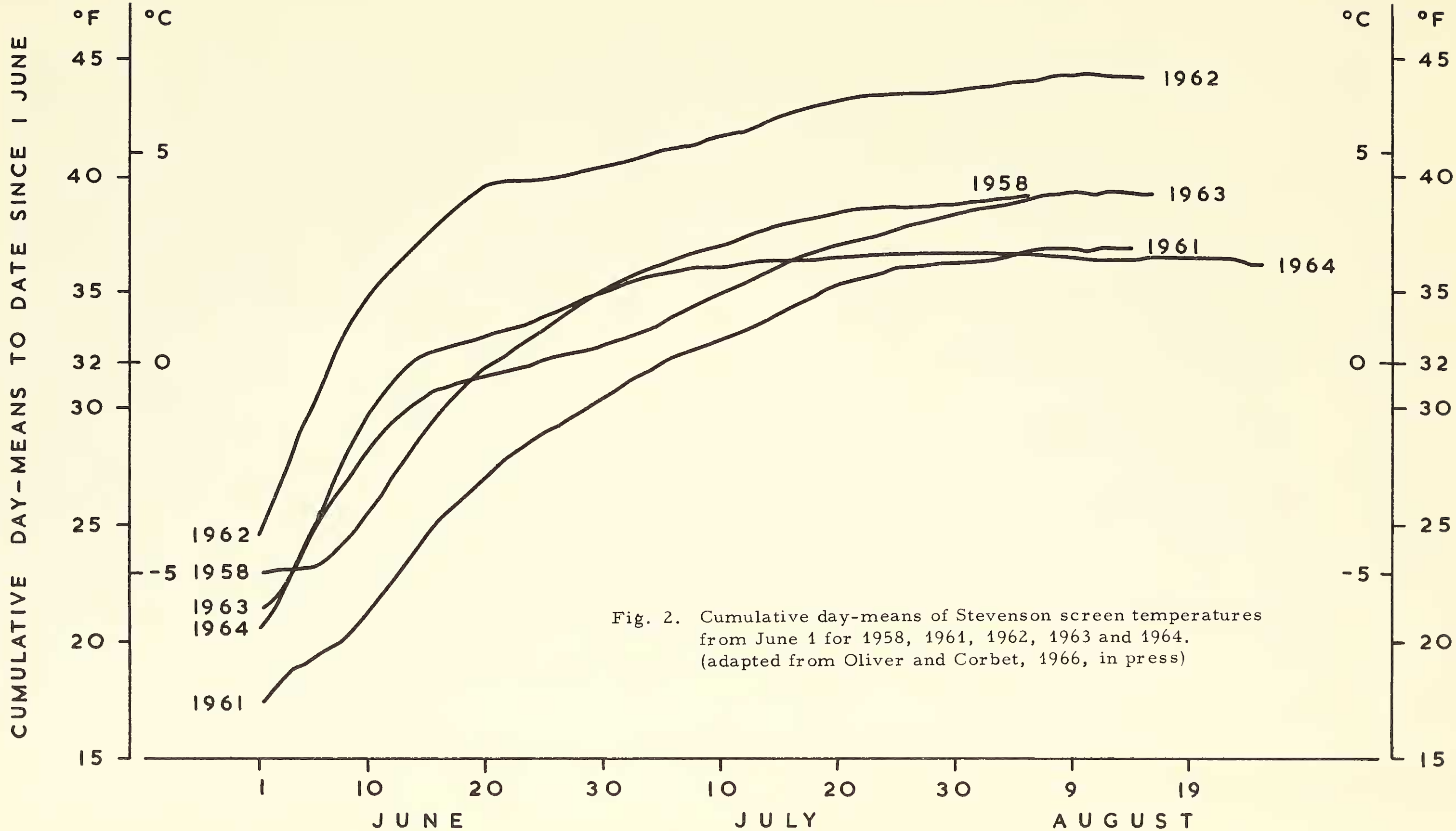


Fig. 2. Cumulative day-means of Stevenson screen temperatures from June 1 for 1958, 1961, 1962, 1963 and 1964. (adapted from Oliver and Corbet, 1966, in press)

of almost 100% relative humidity to exist at or near the surface where the shearing effect of the ground on the wind caused little disturbance of the air at one foot (30 cm) or less (composite data, Jackson 1959 , pp. 127-130, and my notes).

During the summer Lake Hazen enjoys cloudless periods for two to three weeks without interruption.

Night Shadow Areas

In 1963 and 1964 I observed that several species of the spiders were restricted to the night shadow areas. These areas are in the mountain shadow for a minimum of about four to six hours during each 24 hour period at the warmest part of the season, and longer earlier and later in the season. The shadow period is synchronous with night-time in more temperate regions at this longitude. The shadow area extends from the shoulders of Mt. McGill to the line marked off as map coordinates K3 to K6, J7 to J9 to B9 and all the area encompassed (see fig. 1).

MATERIALS AND METHODS

Previous to 1963, possibly ten species of spiders were known from the Hazen Camp area from fewer than two hundred specimens. The program "Studies on Arctic Insects" was instigated by D.R. Oliver of the Entomology Research Institute, Ottawa, and has dealt so far with insects from Isachsen, Ellef Ringnes Island, (McAlpine 1965), and Hazen Camp, Ellesmere Island, (Downes 1964; Oliver 1963). I was given permission to study the spiders from the Hazen Camp area. Studies were begun at the end of June, 1963, and continued until the end of August, 1964, with an interruption during the winter of 1963-1964.

Materials

The structure, identification, and distribution of 20,534 spiders comprising 13 species collected during two summers within the study area were examined. All were collected in the Hazen Camp area. Identified also were 751 spiders from Melville Island (collected by Larry Law), 36 spiders from Tanquary Fjord, Ellesmere Island (collected by Guy Brassard), 18 spiders from Bathurst and Cornwallis Islands (collected by Leonard Hills), and 54 spiders from Thule, Greenland (collected by me). About 522 individuals of two species of Lycosidae were studied in an attempt to determine the length of life cycle.

The field equipment included 50 aluminum cake pans, 23 x 23 x 6.5 cm, used in 1963 and 37 pans used again in 1964. Each pan contained the following fluid mixture to a depth of 2 cm: 600 ml water, 400 ml ethylene glycol, 5 ml formalin, and 1-2 ml of any liquid detergent.

Identifications in the field laboratory were made with the aid of a Wild M5 binocular dissecting microscope with a maximum power of 50 diameters. Identifications, drawings, and analyses in the laboratory were made with a Leitz binocular dissecting microscope with a maximum power of 150 diameters and a 100 watt zircon arc lamp ("Mikrark Illuminator", made by the Boone Instrument Corporation of New York). A

Leitz eyepiece grid 10 mm square divided into 0.5 mm squares and a 10 mm eyepiece micrometre scale with 100 divisions were used in conjunction with millimetre graph paper in preparing the drawings.

The meteorological equipment of Hazen Camp was set up and used throughout the study periods. Equipment included corrected maximum and minimum thermometers, a Feuss corrected millibar barometer, a hygrothermograph, and an anemometer.

A pair of each species will be sent to the following institutions or persons: American Museum of Natural History, New York; Zoologisk Museum, Kystalgade, Copenhagen; Zoological Institute, Uppsala University, Uppsala; Laboratoire de Zoologie, University of Toulouse, Toulouse; Dr. Hermann Wiehle, Dessau; Museum of Comparative Zoology, Harvard University; Department of Entomology, University of Alberta, Edmonton. The remaining specimens will be deposited in the Canadian National Collection, Ottawa. Ten males and 10 females of *Tarentula exasperans* Pickard-Cambridge, 1877, will be sent to the Zoologisk Museum, Copenhagen.

Methods

The study area was examined for the principal ecological zones (based on Savile's notes of 1962). In 1963, a total of 50 traps was placed at carefully selected sites and in 1964,37 traps were used. Eight of the sites in the habitat of some of the less-frequently collected species were used in both years. The new traps of 1964 were in areas not examined in 1963.

The traps were examined once every four days. This interval was selected in 1963 in order to fit into a previously established work pattern, and retained in 1964 for purposes of continuity. Each trap was emptied of spiders and insects and the fluid was replaced or added to.

The traps were set so that the lip of the pan was flush with the ground level. There was usually very little sand drift except in some sites because wind speeds were low. Traps placed in low regions near streams were often flooded by water and the specimens lost. The biggest problem was caused by foxes and wolves which would urinate and defecate into the traps, then scratch sand and any loose vegetation into them. I have interpreted this to mean that they dislike either the pans or their contents. Oliver (pers. comm.) and B. Hocking (pers. comm.), after observing similar behaviour in these animals, have interpreted these actions in the same way. There did not seem to be any way to solve this problem!

Spiders from each trap were preserved and kept in separate vials by trap and by day. Individual spiders were identified to species in the field laboratory. The results of examination of this material are recorded by species on graphs in the text. Identifications were checked, and numbers of individuals per sex per day per trap were also recorded at this time. My analysis of a species habitat is based on where the immatures and females of a species were collected, as males wander. Overwintering sites were used as further evidence of the usual habitat of a species. Except for four species, the immature stages were not identified as identification of immature stages can never be positive. Individuals with anomalies in epigyna and pedipalp organs were examined for mermithid (Nematoda) or other parasites.

All measurements and drawings were made from the microscope. The pertinent sexual parts of large spiders were drawn at 54 diameters, and for the smaller species, at 150 diameters. Measurements of all parts were recorded with each drawing.

Measurements of carapaces were made from directly above the spider. Length is the distance from the base line between the posterior median eyes posteriorly along the midline to the incurve of the hind edge of the carapace. Carapace width was measured at its widest part. The opisthosoma was measured from the dorsal aspect. Total length of the spider was measured from the dorsal aspect from the base line between the anterior median eyes to the end of the opisthosoma.

Measurements of legs and leg parts were always made on the actual dorsal side of the leg. Measurements were made from the proximal to the distal part of a leg segment and did not include the membranes at the joints. Trichobothrium is abbreviated in the text as Tm. The position of a trichobothrium on the metatarsus is expressed as the ratio of its distance from the proximal joint to the total length of the metatarsus. This is expressed as a decimal fraction.

Dictynidae

Dictyna borealis *Pickard-Cambridge, 1877 p. 273 (Figs. 38, 39)*

D. borealis: Bonnet 1956 p. 1431; Holm 1958b p. 534; Braendegaard 1960 p. 7; Chamberlin and Gertsch 1958 p. 136 (in part). *Dictyna* sp. Oliver 1963 p. 176.

Notes on taxonomy - Chamberlin and Gertsch (1958, p. 137) place a few specimens collected by H.W. Levi in the high mountains of Colorado in this species, but the tips of the emboli of those specimens differ in shape from the emboli of specimens collected at Lake Hazen. The latter are definitely members of the species *borealis*. Further, the Colorado specimens are considerably larger than any of the Lake Hazen specimens. Gertsch (pers. comm., 1965) has confirmed my opinion that the Colorado specimens are not *borealis* Pickard-Cambridge, even though they are similar and probably related to the species.

Natural history - This species is a member of the arid arctic faunal element (Braendegaard 1946) and is heliophilic. Specimens are most frequently found on dry, south-facing slopes exposed to the sun, with a vegetation consisting mainly of *Dryas integrifolia*, but often of *Cassiope tetragona*. It prefers hummocked, almost wind-free areas. It overwinters in the vegetation on the surface.

Figure 3 shows the main period of activity of the males of this species. The females are rarely wanderers. The main activity of the males is directly correlated with the courtship and mating periods of the species. The adults are not known to overwinter.

Courtship was not observed in this species, but it cannot be long nor involved, as virgin males and females introduced to one another were found mating within a 45 min lapse of observation. Previous to mating, the males assumed small territories which they defended against all other males, but which females seemed almost coaxed to enter. Defending a territory consisted of actively fighting all male intruders.

Four pairs of spiders were observed mating and both of the male pedipalpi were inserted into the female at the same time. The male was positioned ventral to the female, with the carapace of the male almost touching the prosomatic sternum of the female. There did not seem to be any specified angle as two pairs were lying on their side, the third pair positioned with the female upside down, and the fourth pair with the female rightside up. Mating continued for about 30 min, then each of the four pairs began separating. They did not recouple. Males did not mate more than once.

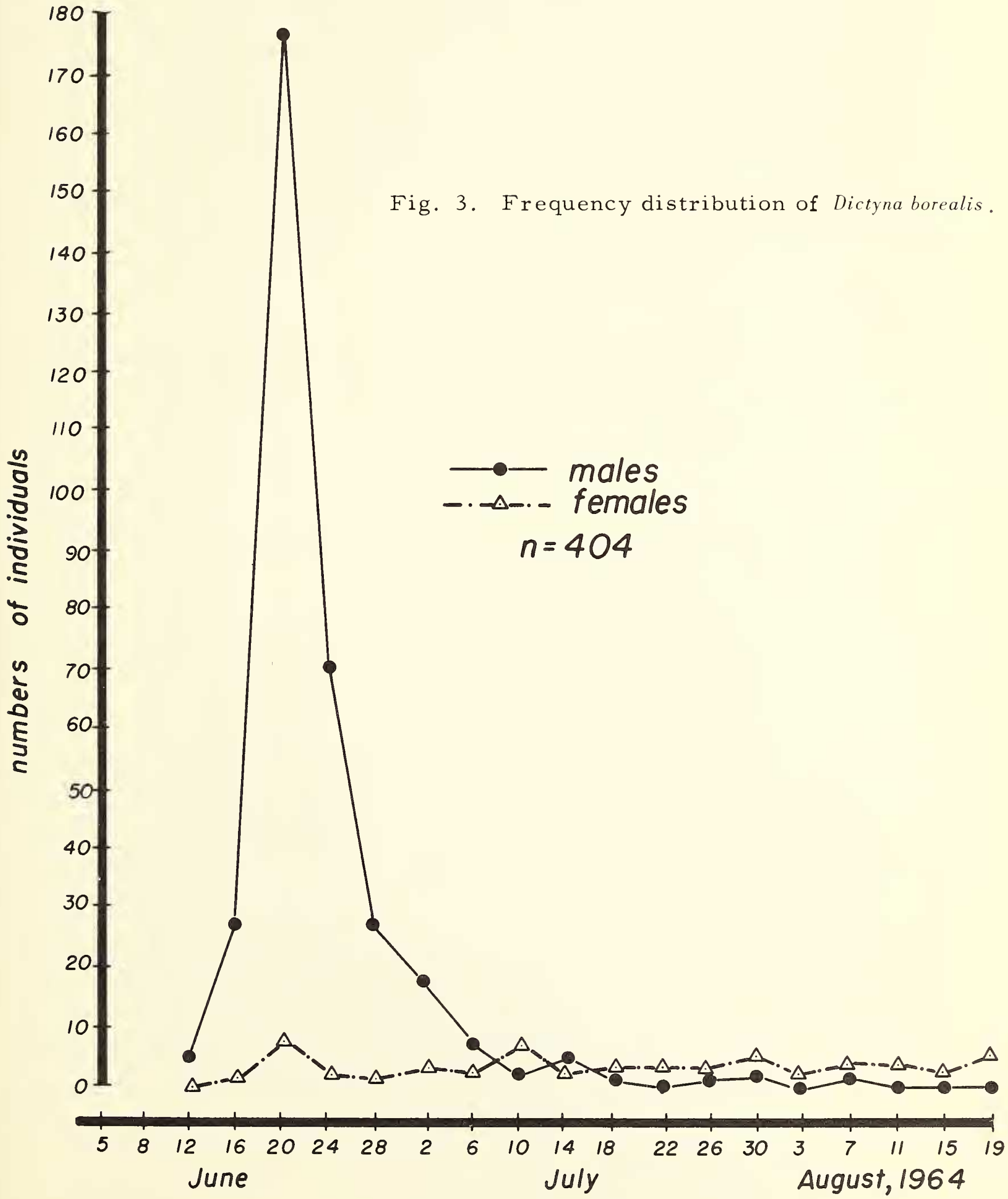


Fig. 3. Frequency distribution of *Dictyna borealis*.

In 1963, I observed that females of *Dictyna borealis* almost invariably deposited their egg sacs and built their webs on the south- and southwest-facing sides of *Dryas integrifolia* hummocks and in the vegetation, but never on the ground. About 30 egg sacs were seen. Laboratory specimens in 1964 also laid eggs in the vegetation. Females remained near the eggs until they hatched. Ten egg sacs were examined and found to contain from eight to thirteen eggs, with a mean of 8.7 eggs per sac.

This species appears to be able to overwinter at any stage except the adult.

When offered a choice of over 30 species of Diptera, this species preferred small ones. Chironomidae and Ceratopogonidae were the main preferences. Cyclorrhaphous Diptera were always refused. No parasites or predators of this species were found.

Material examined - About 625 adults of this species were examined, and all were from Hazen Camp area.

Distribution - Greenland (Peary Land; E. Greenland, 68-77°; W. Greenland, 60-79°N). Ellesmere Island (Hazen Camp area). Bernard Harbour, (58°48'N, 114'W), Mackenzie District, N. W. T.

This species appears to have a relict distribution (fig. 4), though as it is able to balloon, it should be found in more of the Nearctic Region.

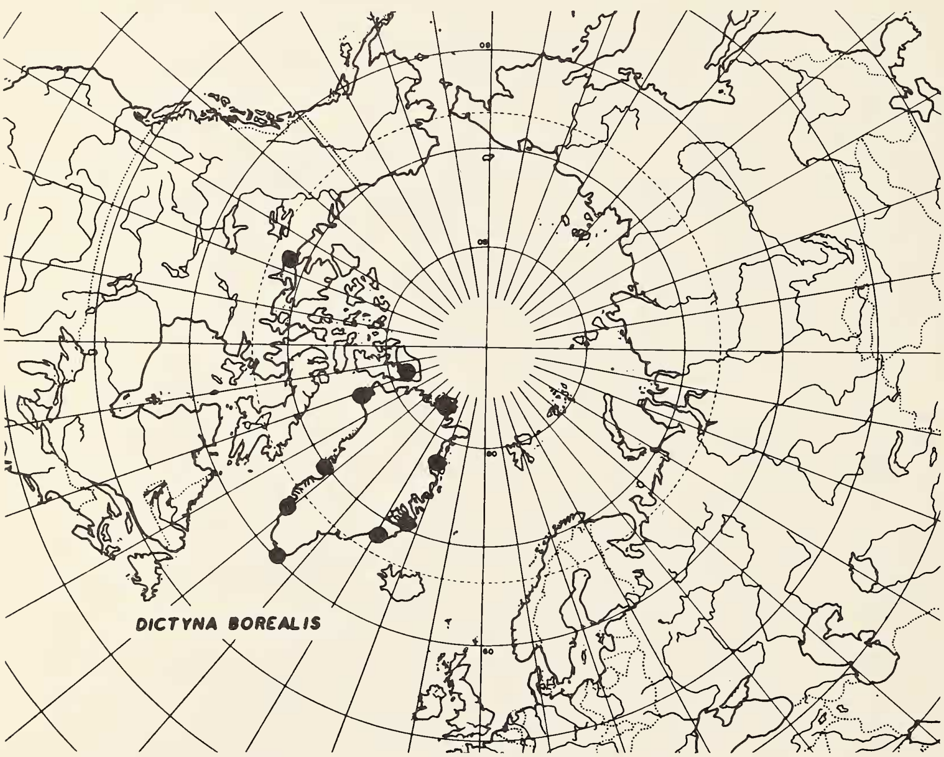


Fig. 4. Distribution map of *Dictyna borealis*.

Lycosidae

Pardosa glacialis *(Thorell) 1872b, p. 159 (Figs. 32-34)*

Lycosa glacialis Thorell 1872b, p. 159. *P. glacialis:* Bonnet 1958 p. 3371; Oliver 1963 p. 176. *L. glacialis*: Holm 1958b, p. 529; Braendegaard 1960 p. 8.

Notes on taxonomy - This species is a member of the genus *Pardosa*, and not of the genus *Lycosa*. The characters of both genera are summarized in Kaston (1948, pp. 321, 331). The egg sacs of *Pardosa glacialis* are a pale green-blue and are lenticular. Those of all known *Lycosa* are white and spherical.

Natural history - Habitat - This species belongs to the euryoequous (euryecious) arctic faunal element (Braendegaard 1946). Specimens are found everywhere except in windy places. *P. glacialis* overwinters in the soil in cracks and under stones on the surface. It has not been found in the overwintering sites at depths greater than 2.5 cm. It does not burrow. Individuals of this species drown easily, hence they will not be found overwintering alive in areas that are inundated or soaked by spring melting of snow and ice. Apparent migrations or mass movements of individuals in the spring are really the successful overwintering individuals radiating from winter quarters.

Figure 5 shows the main period of activity of the males of this species to be between June 29 and July 6. The activity period of males is directly correlated with the courtship and mating period of the species. The adults are not known to overwinter.

Natural history - Courtship - The courtship and courtship preliminaries were observed from the beginning of the season. On June 29, 1964, the eighth day after moulting from the penultimate instar, captured adult males and females suddenly became active in courting. It was noted that the males would court under natural conditions only if heat and light were sufficient. In the laboratory, it was noted that courting started or stopped if a 100 watt bulb were brought to 25 cms or taken away to 75 cms.

When courting was first observed, the males began holding a small territory, and would defend this against all intruders except females. In all, 63 males were observed courting females, 46 in the laboratory and 17 under natural conditions. No variation in courtship was observed.

The males were often seen rubbing the substrate with the venter of the opisthosoma, but sperm webs were never seen. Evidently some species of lycosids spin sperm webs (Gertsch 1949, p. 73) and some do not (Savory 1928, p. 224).

Courtship is summarized as follows: on June 29, 1964, a male was observed in the beginnings of courtship. The palpi, bent downward at the patellae, were moved in a circular motion which, when viewed from above, appeared clockwise in the right palpus, and anticlockwise in the left. Simultaneously, the first pair of legs were lifted and extended horizontally forward, then gradually relaxed while extended. When the tarsi of the first legs touched the ground, the palpi stopped churning. The palpi started rechurning when the legs, brought back toward the carapace and raised, started extending forward.

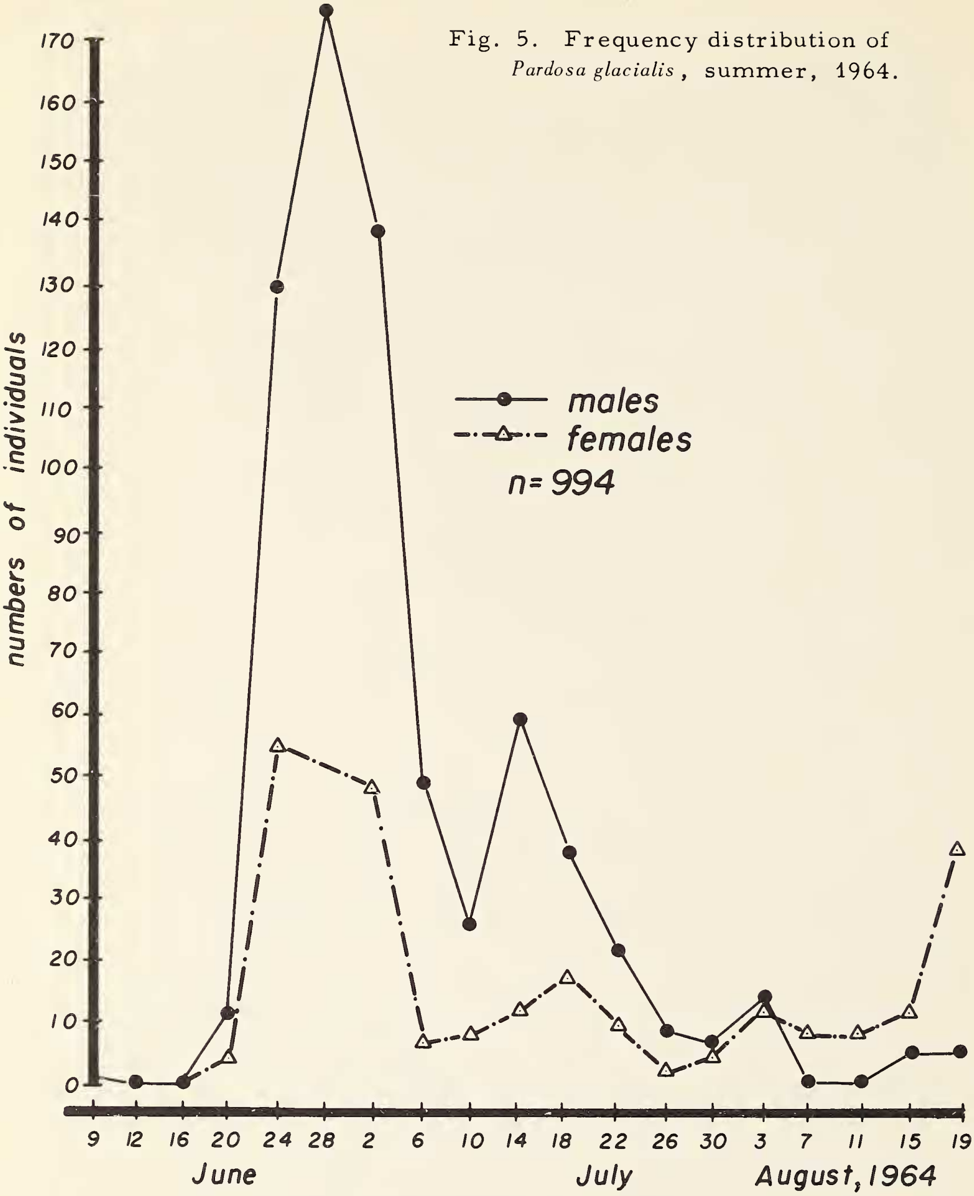


Fig. 5. Frequency distribution of *Pardosa glacialis*, summer, 1964.

Associated with these waving motions was a characteristic weaving of the body. First, the waving motions were started in a position which squarely faced the female, who was usually some 10 cm distant. The male then turned 30° to the left and vigorously made the waving motions, turned toward the female and repeated the waving, then turned 30° to the right and again repeated the waving motions, then centre, then left . . . until within two cm of the female, at which point the weaving was cut to two positions, each about 20° from centre. The right-left weave and associated waving motions were continued vigorously until either the female chased the male away, or until their legs touched, at which point the female suddenly assumed a defensive position with fangs spread open and the first two pairs of legs raised up and forward. In this position, the female charged forward for about one cm, and the male fled for about 15 cm, then turned and again started the same advance procedures. Almost invariably, the males approached the females from the front.

On June 30, 1964, most of the males were dead. Mating had presumably taken place in the late afternoon of the previous day.

Previous authors have argued whether the male's courtship reaction was precipitated by sight, smell, contact, or a combination of all three. It is my opinion that courtship by individuals of *P. glacialis* was initiated by chemo and contact stimuli rather than by sight or touching of the ground over which the females had passed. The opinion is based on the following observations. Virgin males placed in cages that had previously held females did not become "excited", but virgin males placed in cages with females present became "excited" by leg contact with the females and began courting within 25 minutes. The initial reaction of the males after contact was to withdraw to a corner and start cleaning the whole body, legs, and palpi. The cleaning usually lasted about 20 minutes. The males then ventured out slowly, and at first fled at the approach of either a male or a female. Courting began shortly thereafter. Osterloh (1922) rightly concluded that the necessary stimulus for male spiders is different in different species. The condition of the male and female should be known when the observation was made. For instance, had observations at Hazen Camp been made only on males that had previously touched females, the conclusions might have been that sight is the "triggering" mechanism.

Mating was never observed in *P. glacialis*, but one male which had repeatedly been shunned by all females, began courting a large male Chironomid, which was lying on its side almost dead. The male eventually mounted the fly in the usual *Pardosa* manner (Kaston 1936, p. 167), it then discovered the mistake and ate the fly.

Natural history - Egg laying - Within 48 hours after mating, the females were ready to lay eggs. Four females were observed during the whole egg-laying process. Because there were no observable differences during the egg-laying, the general pattern is described as follows. The female located a sheltered flat place which lay pocket-like between and under several rocks. She then started making a thin flat sheet of webbing about 2.5 cms in diameter. In the centre of this the female made a small, much-thicker patch of webbing about 0.8 cm in diameter which was of a different silk material than the main sheet web. The centre patch was slightly green and opaque. These preparations took about 30 min.

The female then placed her genital region over the small centre patch and started laying eggs at the rate of one egg each 50-60 seconds until the usual 50-53 eggs were laid. Each female appeared to rest for about ten minutes, then made the covering for the sac. The silk material for the upper and lower halves of the egg sac was the same. The upper half of the sac was attached to the lower half with such firmness that the lower half became somewhat bowl-shaped when only half the upper covering was made.

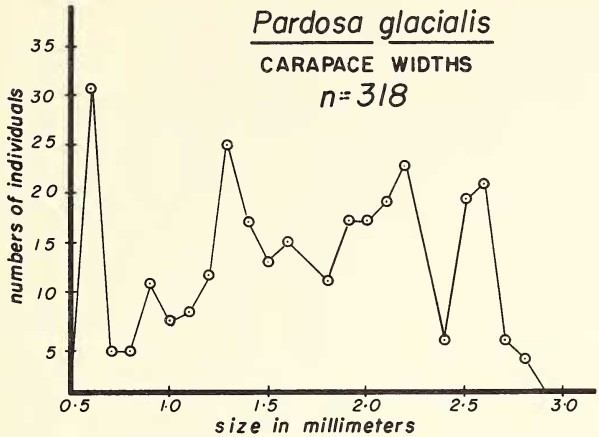
The female made the cover for the upper half by attaching a thick silk line to one side of the centre patch, then swung the opisthosoma up and over the eggs to the far side. As the silk lines were attached, the female rotated about the eggs making a complete cover. This operation lasted about 35 minutes. Again the female rested before cutting the egg sac free with either the chelicerae or endites. The female then turned and placed the spinnerets over the sac and attached them to it. The female then waited for over an hour, emerged from the hole with the sac attached, and the opisthosoma tilted up so that the sac did not drag on the ground.

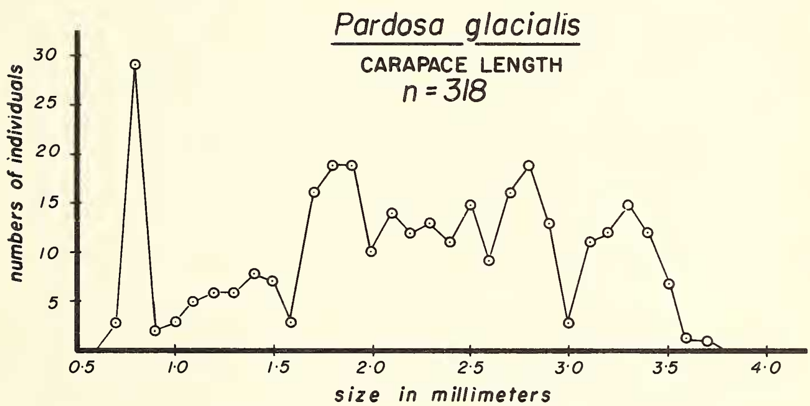
I was not able to keep any of the caged females alive until the young emerged. Whenever a female died, I examined the egg sac to note the development of the eggs, but in no case were any young seen. On August 19, 1964, a female was captured with young that had just hatched from the egg sac. These were the only young seen of this species that hatched in 1964.

Number of instars and longevity - On the basis of analysis of mensural data obtained from 318 individuals of this species, it appears that there are seven instars from the egg to the adult (fig. 6). The first instar is spent inside the egg sac, and the second instar emerges from the egg sac and crawls onto the opisthosoma of the mother. If it is assumed that on the average each instar lasts one year, then the length of the life cycle of this species is about six years.

Solar escape orientation - Three groups of specimens were used for the experiment, one group encountered in the field and left alone except for the period of encounter, and two groups that were captured. One of the captured groups was kept outside where the sun could be seen on clear days. This group was maintained in order to assure having a control group to contrast with the group kept in the laboratory. The second captured group was maintained in the laboratory with a 100 watt bulb shining from the geographic east about 25 cm from the cage. The purpose of maintaining this group was to see if the solar orientation could be interrupted or disturbed, and that this occurred is apparent from the results summarized in figures 7, 8 and 9. The longer the specimens were kept in the laboratory, the greater became their confusion when released. Directions were often so unsure that a spider would turn almost 360° in a 5 cm circle before slowly going in a direction, and then it was as often towards as away from the sun rather than at right angles to it, as seen from the charts of the specimens kept outside or encountered in the field (figs. 7, 8, & 9). Each specimen used in the laboratory experiment was kept inside for a minimum of nine days before being used in the experiment. In no case was the same spider tested more than once in a three hour period, as it was found that individuals became tired and gave different initial results at each escape.

Experiments were begun on July 2, 1964. Only adults or subadults were used as the younger spiders showed preference for well-protected, vegetated areas and their escape reactions were either to remain still or else hide in the vegetation. Parasitized adults and subadults were also omitted from the experiment when it was found that their escape reactions were considerably altered. The parasitized spiders show little or no escape reaction. In fact some refused to move unless prodded with a stick.





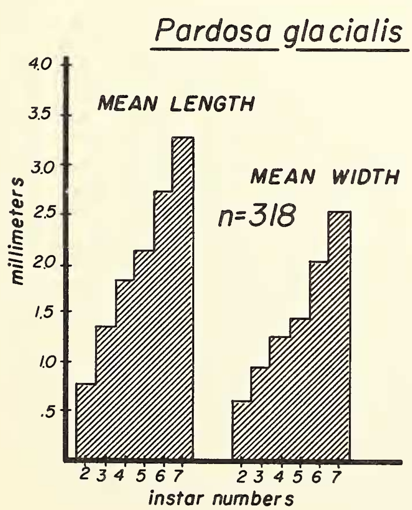


Fig. 6. Frequency distribution of dimensions of *Pardosa glacialis*.

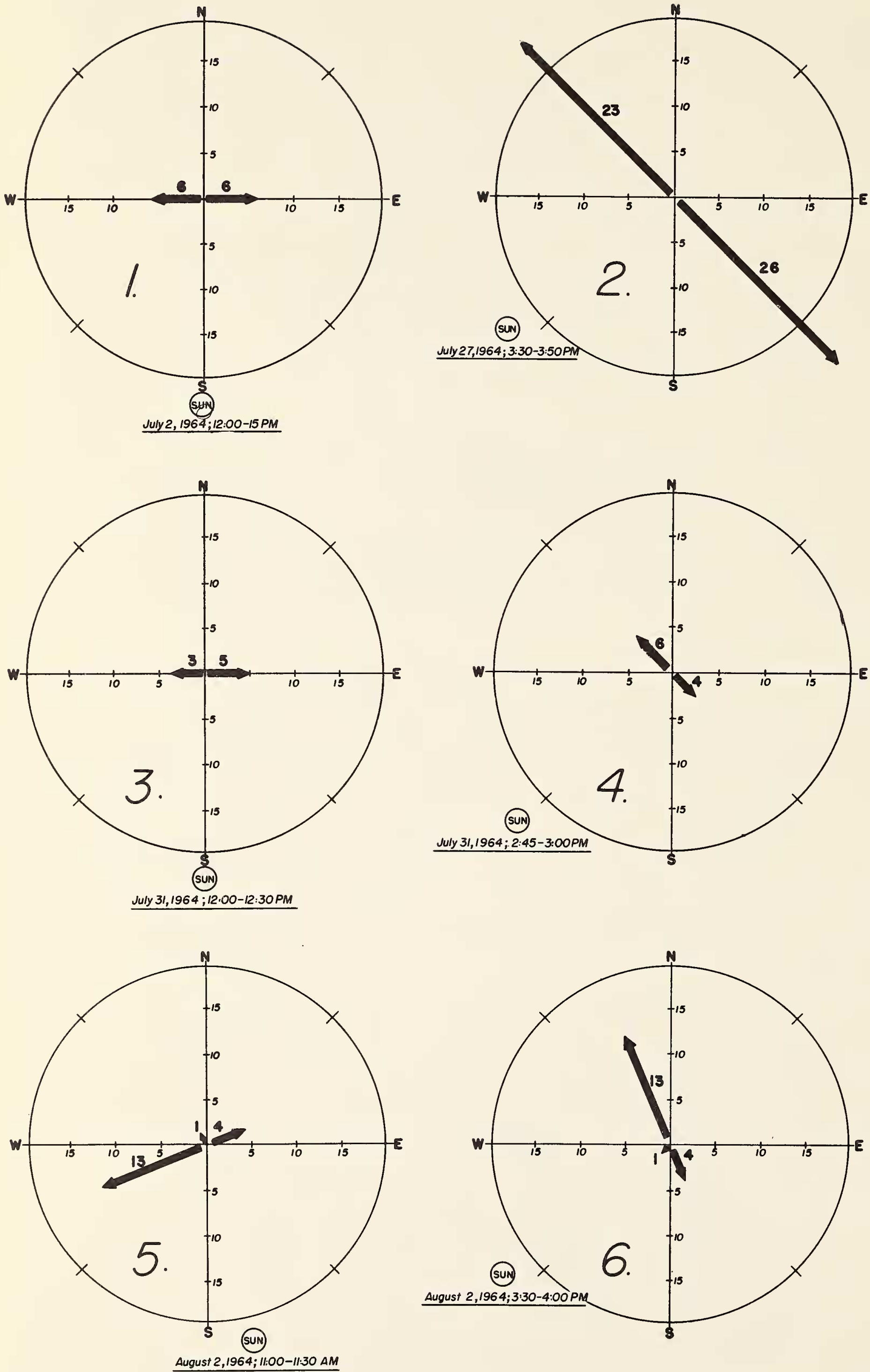


Fig. 7. Escape directions of *Pardosa glacialis* in the field observed under natural conditions.

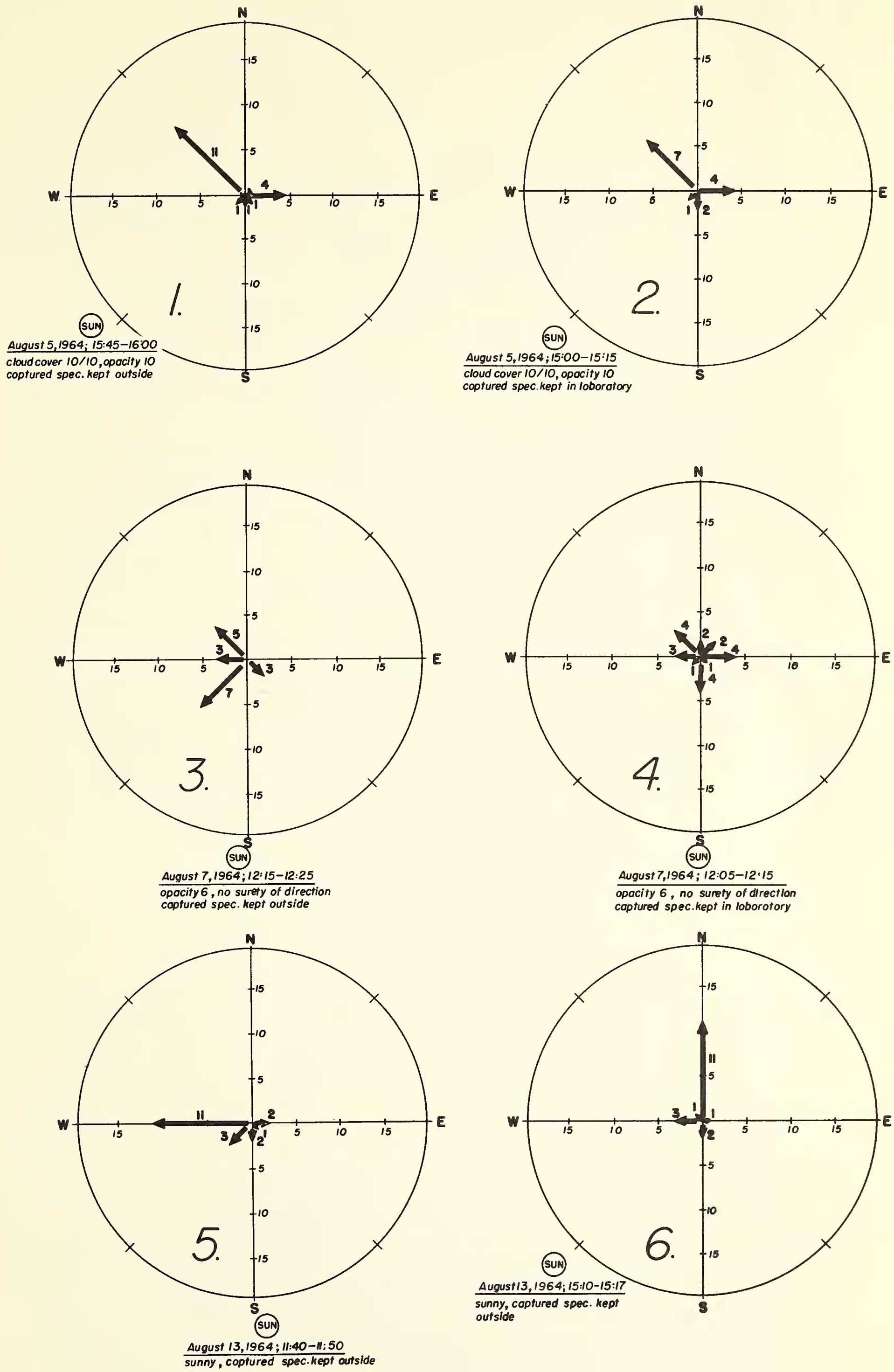


Fig. 8. Escape directions of specimens of *Pardosa glacialis* kept in sunlight and specimens exposed to a 100 watt lamp shining from the east .

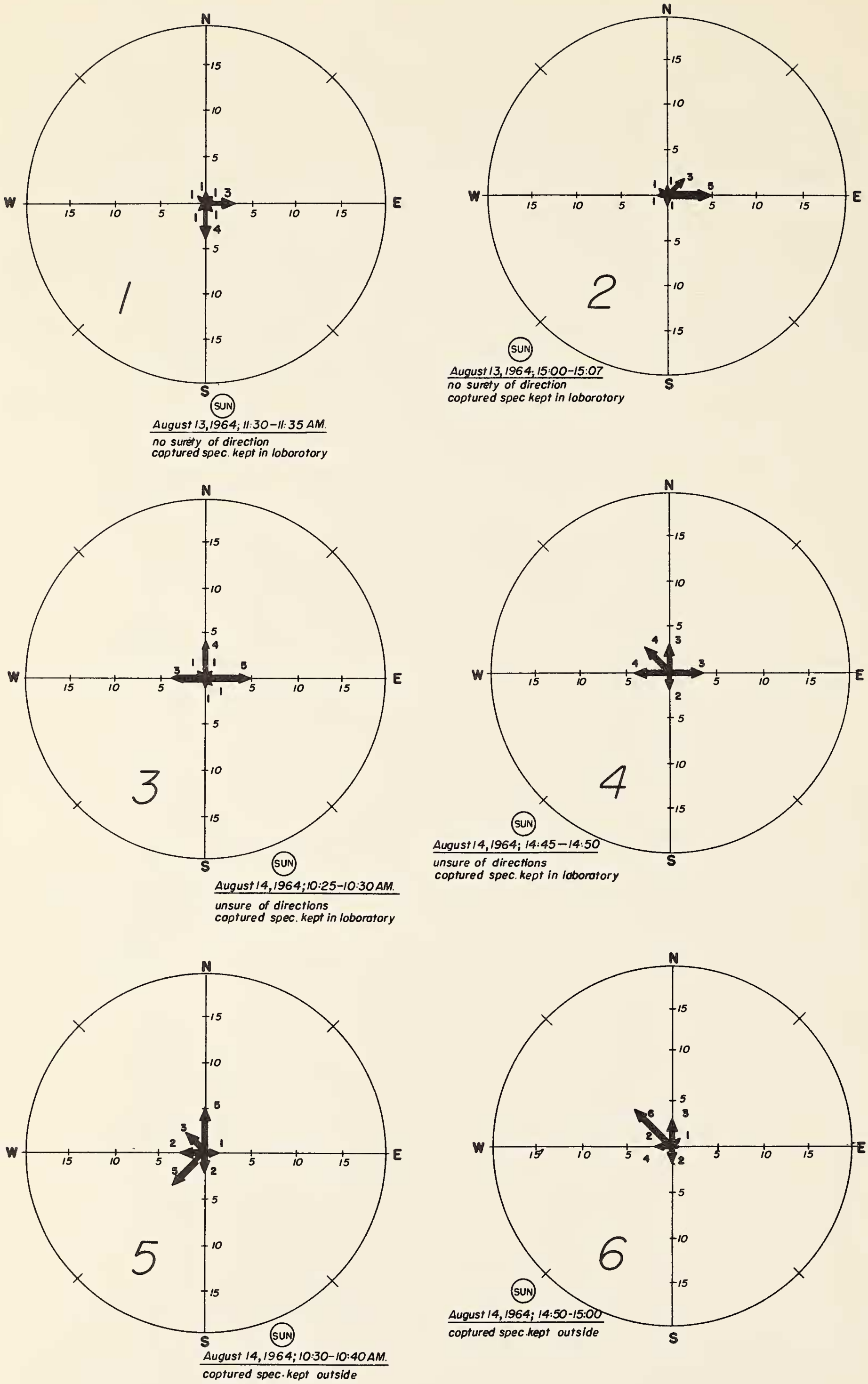


Fig. 9. Escape directions of specimens of *Pardosa glacialis* kept in sunlight and specimens exposed to a 100 watt lamp shining from the east.

The results of the Lake Hazen experiments are as follows: *Pardosa glacialis* encountered in the field or kept under somewhat natural conditions attempted to escape at approximately 90° right or left to the sun's position. The group kept in the laboratory showed, in time, almost complete disorientation of escape direction. Individuals encountered in the field and placed in the shade before being startled, escaped directly away from me, but upon entering the sunlight, turned and ran at 90° to it. Aged or senile individuals tended to show less and less orientation as the season progressed. Cool weather also inhibited escape reactions as spiders apparently tried to get warm rather than escape.

I suggest that the escape direction of *Pardosa glacialis* in relation to the sun - that is, to the right or left - is not intrinsic to each individual, but a function of the direction in which the spider is facing, at rest, immediately prior to the time of the escape. The spider's resting position is one that will allow it to present most of its body to the sun at one time. In mid-afternoon, for example, this would mean on a line running northwest to southeast, and from the graphs it can be seen that most of the spiders tried to escape to the northwest (figs. 7.2, 4, 6; 8.1) or southeast (fig. 7.2, 4, 6).

Papi and Syrjämäki (1963) have conducted similar experiments with *Arctosa cinerea* (Fabr.) (Lycosidae), but have obtained different results. They have combined results of testing periods of rather long duration -- usually six hours. I feel that for these experiments long periods obscure the results. Therefore, I have recorded results for 15-25 minute periods so that variations in the spiders' reactions can be more easily observed in relation to variation in the sun's position. Tests were made in the mid-morning and again in the late afternoon. Further, no theoretical escape direction has been assumed or considered.

Food, parasites & predators - This species fed most readily on Chironomidae, and when hungry, fed on the smaller cyclorrhaphous flies. Blow flies and other flies of this size were left untouched. The species is also highly cannibalistic, but was not observed feeding on other species of spiders.

Remains of *P. glacialis* were found in the crops and gizzards of several snow buntings and knots. No previous information about vertebrate predators of this species was found.

Various degrees of parasitic castration in male and female *P. glacialis* by nematodes of the genus *Hexamermis* (Mermithidae) have been observed at Hazen Camp. About one per cent of the specimens collected were infected and most of these were females. Possibly more careful examination of all the Hazen Camp specimens of *P. glacialis* might reveal a considerably higher rate of parasitism, for a parasitic infection is very hard to detect in the young spiders.

The ultimate effect of the parasite on the spider is death, as just before *Hexamermis* emerges from the opisthosoma of the spider, the essential organs of the spider are eaten. Spiders examined just after a parasite had emerged were found to be lacking in the main prosomatic muscles, the entire digestive system, fat body, and the entire reproductive system. An infected spider usually stopped feeding about one week before the parasite emerged, and during the last week such spiders were seen drinking quantities of water.

When the parasite was about to emerge, the spider crawled into a dark hole or corner. It took about 20 minutes for *Hexamermis* to emerge completely from the anterior end of the opisthosoma. The spider died 30-60 minutes before the *Hexamermis* first emerged.

Some of the obvious external morphological characteristics for *Hexamermis* infection are these: lopsided or greatly enlarged opisthosoma; epigynum altered from the normal; legs shorter and thicker; sluggish or inactive spider; and some secondary sexual characteristics of the male not present or barely developed. A normal male appears gaunt and thin, but a parasitized male appears fat like a female full of eggs.

Parasitic castration in lycosids by *Mermis* has also been described by Åke Holm (1941) and some examples that might be caused by parasites are cited and illustrated by Kaston (1961, 1963a, 1963b).

Material examined - Approximately 3383 adults of this species were examined from Hazen Camp, one female from Payne River (59°30'N), Quebec, four males from "Manitoba", one male from Umiat, Alaska, four females and three males from Mesters Vig, E. Greenland, six females from Holsteinborg (approx. 63°N), W. Greenland, and one female from Axel-Heiberg Island (Heinz Rutz, collector, 1963).

Distribution (fig. 10) - Greenland (East, 68-77°N; West, 61-75°N; Peary Land, 82-83°N). Ellesmere Island (76-82°N). Axel-Heiberg Island (79°25'N, 90°45'W). Baffin Island. Southampton Island. Manitoba. Umiat, Alaska. Payne River (59°30'N), Quebec.

Pardosa glacialis appears to be a nearctic species only.

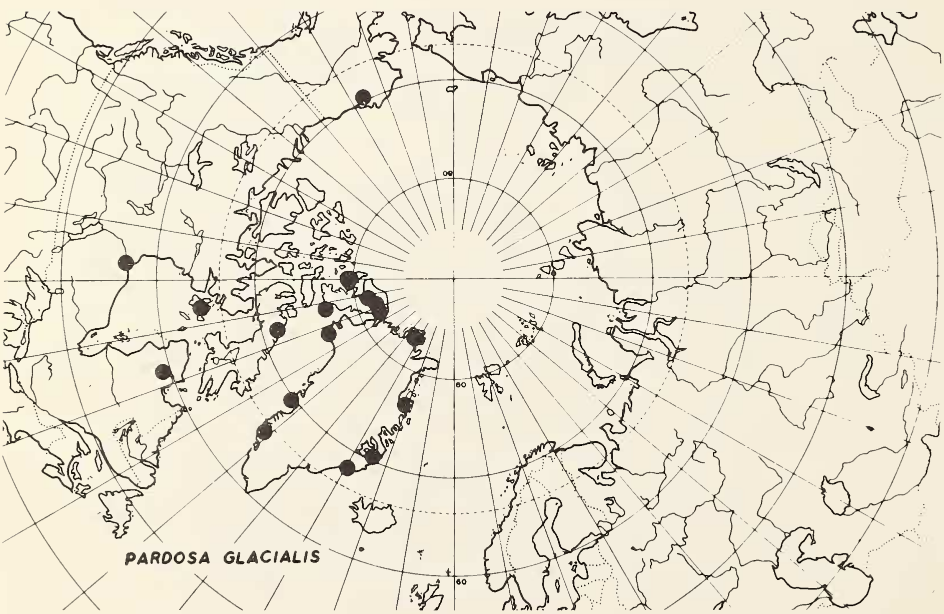


Fig. 10. Distribution map of *Pardosa glacialis*.

Tarentula exasperans *Pickard-Cambridge, 1877, p. 283;* *(Figs. 35-37)*

Arctosa exasperans: Bonnet 1955 p. 647; *T. exasperans:* Oliver 1963 p. 176, Braendegaard 1960 p. 8.

Notes on taxonomy - There has been some confusion about the classification of this species, mainly because of the scarcity of specimens in museums. Gertsch (1934) and Braendegaard (1960) have correctly replaced this species in the genus *Tarentula* .

Description - Braendegaard (1960, p. 10) has described the female of this species and has measured the sizes of a male and a female. I have remeasured a Peary Land specimen and a number of the Hazen Camp specimens, and find Braendegaard's measurements a little more than half of mine. Table 1 shows the measurements of individuals of this species from Hazen Camp.

TABLE 1 - Mean dimensions of *Tarentula exasperans* in mm.

	Carapace		Total Length
	Length	Width	
♂♂ (20 specimens)	3.35	2.76	7.06
♀♀ (10 specimens)	3.78	2.96	8.73

Natural history - This species is a member of the arid arctic faunal element, and is the most pronounced heliophile of all the species found at Hazen Camp. *T. exasperans* was taken only on dry southwest and south-facing slopes (rarely on southeast-facing) in and near clumps of *Dryas integrifolia*. Where this species is abundant, *P. glacialis* was almost never found except for occasional wandering males. *T. exasperans* overwinters by burrowing about 2.5 cm into the ground at the bases of *Dryas integrifolia*. It was never found in the night shadow areas or areas of slopes of more than 20°.

Figure 11 shows the main period of activity of the males and females of this species. The females are never as active in wandering as the males. Sexual activity of the males is between June 28 and July 6, though they can be found before and after these dates. The adults are not known to overwinter.

Newly emerged males and females were collected on the day they emerged, and then kept in separate cages for one week. On June 29, 1964, a male was introduced to a cage containing four females. Upon contact with a female, the male seemed to become excited. There was a short sparring contact, then each fled in different directions. The female went for about 5 cm and stopped, but the male began running about in small circles and figure-eights as though injured, with the front two pairs of legs drawn up against the carapace. Upon each contact with a female, the scurryings were intensified.

On June 30, 1964, two males and two females were placed in a large cage outside. On July 5, the males began courting the females. In all, five males were observed courting females, and there were no obvious differences. In this pattern of courtship the male approached the female, and at contact became more active and began circling and scurrying. Thereafter, the male approached the female almost invariably from behind, and tapped the female on the opisthosoma or fourth leg with his first legs. The female merely lifted a leg, and the male scurried off, but quickly returned and tried again. On the ninth or tenth try, the male retired for about five minutes.

The above procedures were watched for over five hours continuously, but no males were successful at mounting a female. The males were found dead the following morning. There was no mating observed for this species, nor even any partial attempts at mounting.

On July 6, 1964, a female and egg sac appeared in the outside cage. The process for egg-laying is as follows. The female *T. exasperans* laid eggs and made the egg sac in much the same way as *Pardosa glacialis* (see p. 165). The difference was that *T. exasperans* dug a hole in the ground about 2 cm deep and at the bottom of the hole made a round cavity about 1 cm in diameter. Once in the hole, the female closed over the entrance with webbing. The hole was completely lined with silk. The whole process, including the hole digging, took about four hours, but the female often remained inside the hole for another three to six hours. When the female emerged, the light brown egg sac was attached to the spinnerets. The egg sacs were larger and rounder than those of *Pardosa glacialis*. There are about 70 eggs per sac of *T. exasperans*. There is no great size difference between egg sacs.

The young were never observed clustered on the opisthosoma of the female as were the young of *P. glacialis*. About 204 specimens of various instars were examined to determine the number of instars and length of life cycle. The results were poor, mainly because there were a great many adults and penultimates, but very few of the preceding instars. However, by inspection, it appears that there may be as many as seven or eight instars, and a life cycle that may last six or seven years, if it is assumed that each instar lasts about one year.

No escape orientation was observed in *Tarentula exasperans* males or females, as the species relies on cryptic colouration rather than speedy retreats to elude enemies and predators. The gray and black colouration makes individuals almost invisible when they are in or near the dead leaves of *Dryas integrifolia*. Specimens observed in the field did not run at my approach but remained still. Even when the ground was shaken under them, they moved only if their positions were somewhat precarious.

It was found by experiment that this species prefers the smaller Diptera so abundant at Hazen Camp, though Collembola will be eaten if caught. Small blow flies (*Phormia* and *Protocalliphora* spp.) were refused even when the wings were cut off, perhaps because *T. exasperans* has very small chelicerae for a spider of its size. No parasites or predators of this species were observed, nor was cannibalism seen.

Material examined - About 397 adults of this species were examined

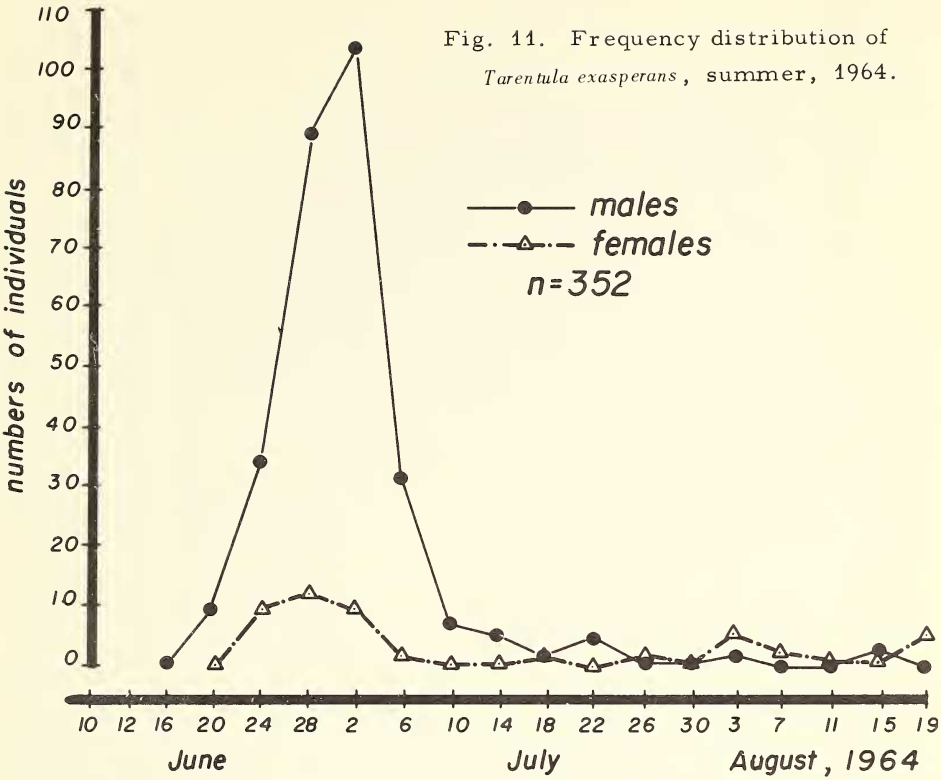


Fig. 11. Frequency distribution of *Tarentula exasperans*, summer, 1964.

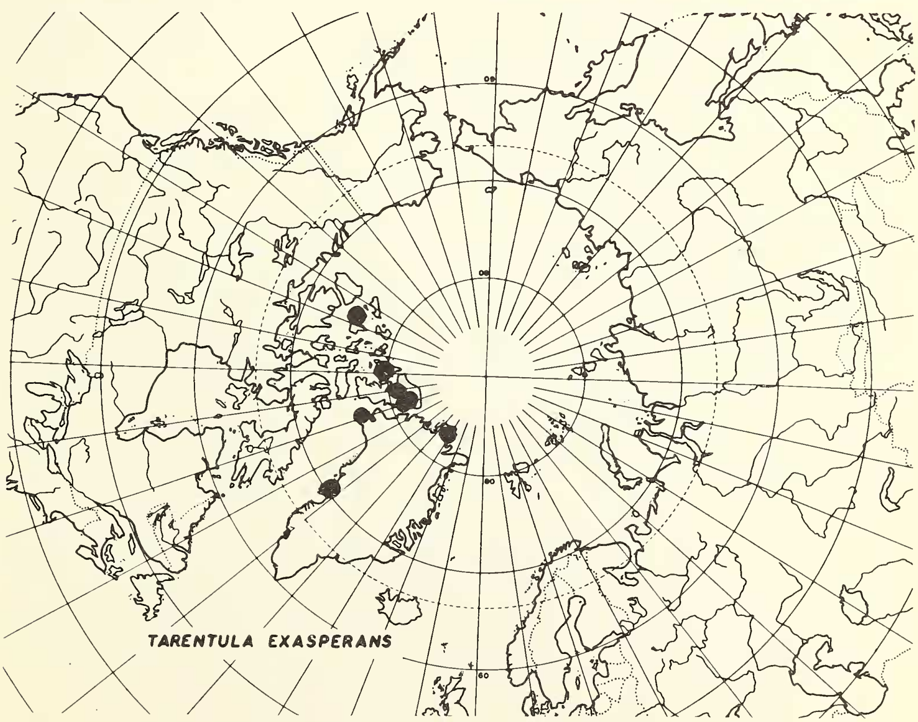


Fig. 12. Distribution map of *Tarentula exasperans*.

from Hazen Camp, one male from Peary Land, Greenland, which was loaned by the Zoological Institute in Copenhagen, three females and one male from Umanak, Greenland, loaned by the American Museum of Natural History, New York, one male and seven immatures from Tanquary Fjord, Ellesmere Island, 10 immatures from Axel-Heiberg Island (Heinz Rutz, collector, 1963), and three males and 34 immatures from Melville Island (J. E. H. Martin, collector, 1965).

Distribution (fig. 12) - Greenland (Peary Land; Umanak, 70° 40'N; Saunders Island, 76°35'N, 69°45'W). Ellesmere Island (Discovery Harbour, 81°45'N; Hazen Camp; Tanquary Fjord, 81°28'N, 76°50'W). Axel-Heiberg Island. Melville Island (74°58'N, 115° 00'W). This species is known only from the high Nearctic Region.

Linyphiidae

Collinsia spetsbergensis *(Thorell) 1872 (Figs. 65, 69)*

Erigone spetsbergensis Thorell 1872 p. 692. *Typhochraestus spitsbergensis:* Bonnet 1959 p. 4747, *C. spetsbergensis:* Holm 1960b p. 512; *C. spitsbergensis:* Braendegaard 1960 p. 11.

Notes on taxonomy - According to Åke Holm (pers. comm. 1965), Thorell's paper (1872) was written in Swedish, and since Spetsbergen is Swedish and Spitzbergen is German, the spelling *spetsbergensis* must stand as valid, despite Bonnet's (1955, p. 74; 1959, p. 4747) comment to the contrary.

Description - Female. Color: carapace brown, marked and shaded with dark brown; chelicerae pale yellow-brown with brown specks on the basal half; sternum brownish; labium brown, rimmed with gray; pedipalp coxae brownish, gnathobases pale gray, abdomen gray-brown; spinnerets gray-brown.

Structure: size, moderately small, about 2.25 mm long; carapace distinctly longer than wide, about 0.86 mm x 0.69 mm, gradually rising to the cephalic region, then sloping downward to the eyes; cephalic lobe lacking; clypeus height about 3.5 to 4.0 diameters of an anterior median eye; posterior row of eyes slightly procurved; posterior medians slightly smaller than the laterals and all about equally spaced at 2.0 diameters of one median; anterior row almost straight, but slightly recurved; anterior medians slightly more than 2.0 diameters of one from the laterals; median ocular quadrangle longer than wide and wider posteriorly; promargin of cheliceral fang groove armed with five stout teeth; chelicerae slightly reclined; legs moderately long.

Tibiae I-III each with two spines; tibia IV with one spine at 0.41; trichobothrium (Tm) I about 0.64; Tm II about 0.61; Tm III about 0.46; Tm IV lacking.

Male. Color and structure: like those of the female, except for the following: total length about 2.0 mm; carapace longer than wide, about 0.80 mm x 0.74 mm.

Tibia I-III with two spines; tibia IV with one spine; Tm I about 0.56; Tm II about 0.50; Tm III about 0.47 or 0.48; Tm IV lacking.

Natural history - This species is a member of the humid arctic faunal element (Braendegaard 1946). Specimens are usually found in river deltas in areas with fine, muddy sand covered with dense *Equisetum* and some *Salix*. These areas are always very wet or damp, and are occasionally flooded in the spring. If the ground begins to crack with dryness, then *C. spetsbergensis* retreats into these cracks.

The adults are found throughout the season, though there is a slight increase of captured adults at the end. The species overwinters at the bases of the vegetation but not, so far as is known, as adults.

No parasites or predators were observed preying on this species, but it can be assumed that the young are eaten by other species and by their own adults.

Material examined - About 22 adults were examined from the Hazen Camp material, two females from Marie Bay, Bathurst Island (Leonard Hills, collector, summer, 1964), three females and two males from Bailey Pt., Melville Island (J. E. H. Martin, collector, 1965), 164 adults from Weatherhall Bay, Melville Island (Larry Law, collector, summer, 1964), one male from Isachsen, Ellef Ringnes Island (J.F. McAlpine, collector, 1960), two females from Alert, Ellesmere Island (personal collection, 1963) and four males and 17 females from Axel-Heiberg Island (Heinz Rutz, collector, 1963).

Distribution (fig. 13) - Alaska (Arctic Coast). Marie Bay, Bathurst Island. Weatherhall Bay and Bailey Point, Melville Island. Hazen Camp and Alert, Ellesmere Island. Isachsen, Ellef Ringnes Island. Greenland (Peary Land; E. Greenland, 62-65°N; W. Greenland, 70°N). Iceland. Spitsbergen. Sweden. Novaya Zemlya. Siberia. New Siberian Islands. This species is high Holarctic in distribution.

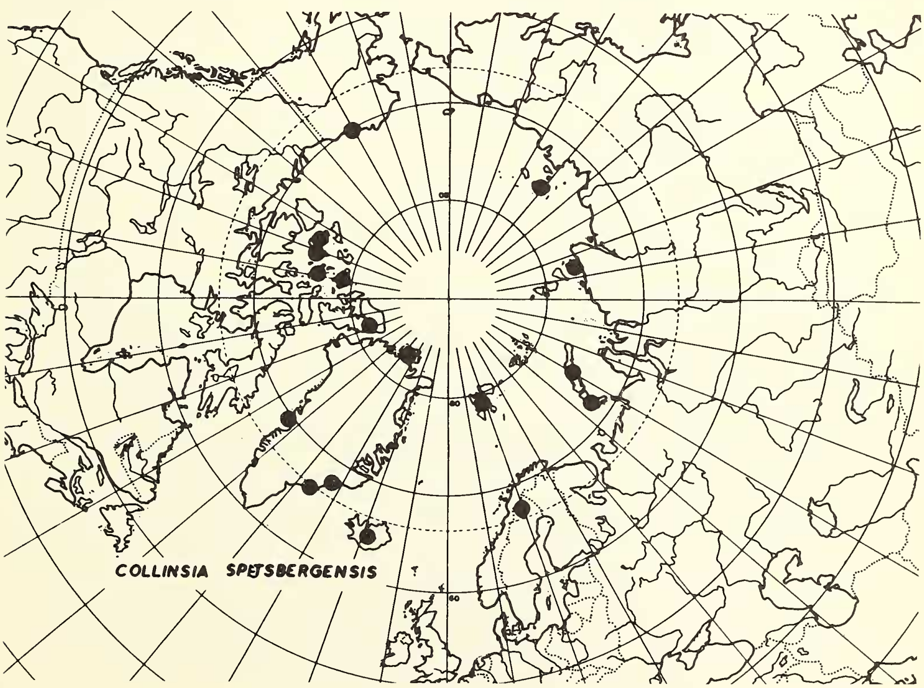


Fig. 13. Distribution map of *Collinsia spetsbergensis*.

Collinsia thulensis *(Jackson) 1934, p. 611 (Figs. 66-68)*

Coryphaeolanus thulensis Jackson 1934 pp. 614, 615, 618; *C. thulensis:* Bonnet 1956 p. 1231. *Collinsia thulensis:* Holm 1958a p. 48; b p. 531 , 1960a p. 112; Braendegaard 1960 p. 12.

Natural history - This species is a member of the humid arctic faunal element. Specimens are most commonly found in gravelly parts of river deltas with scanty vegetation, mostly *Dryas integrifolia* and *Salix arctica*. *C. thulensis*, in contrast to *C. spitsbergensis*, is active mostly during the early part of the season. Overwintering forms were not found, but it appears from the habitat that the species overwinters on the surface of the ground, perhaps under some of the stones or in the vegetation.

The active breeding period is indicated in figure 14. Note the low number of adults caught at the end of the season. From this I assume that the adults do not overwinter.

Captured specimens kept in cages fed readily on mites and Collembola, but refused all flies offered, including very small Ceratopogonidae.

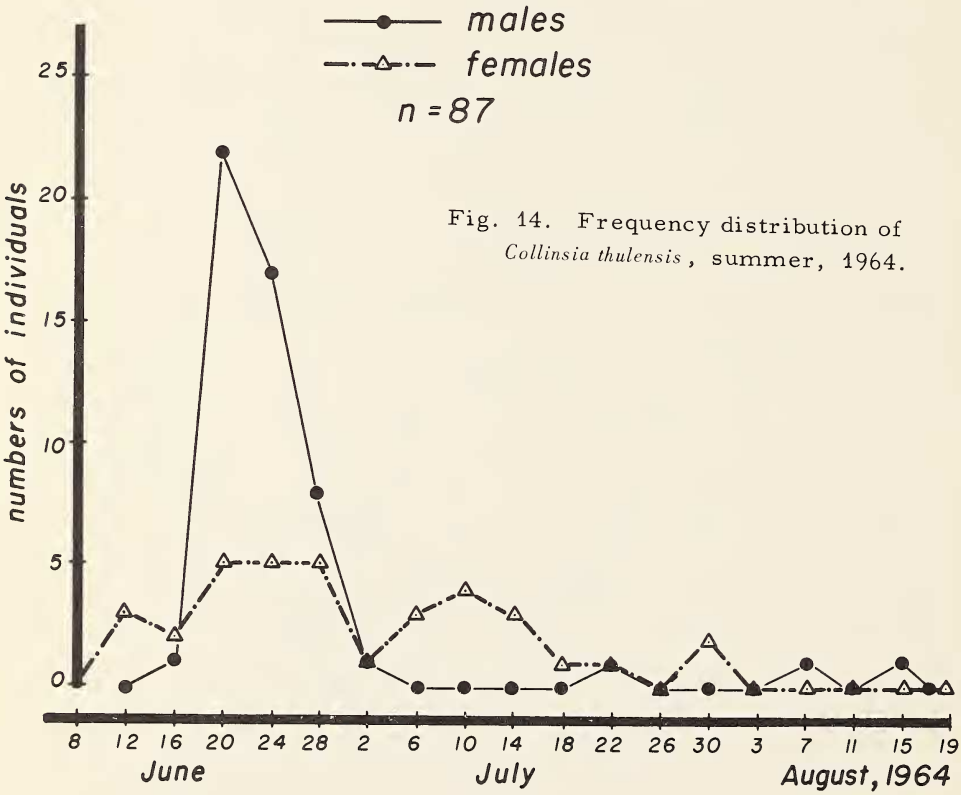


Fig. 14. Frequency distribution of *Collinsia thulensis*, summer, 1964.

Material examined - About 100 adults of this species were examined from Hazen Camp, six females and one male from Thule, Greenland (personal collection 1964), and one female from Axel-Heiberg Island (Heinz Rutz, collector, 1963).

Distribution (fig. 15) - Kotzebue, Alaska. Hazen Camp, Ellesmere Island. Axel-Heiberg Island. Greenland (Thule; Peary Land; and between 70-75°N in E. Greenland). Spitsbergen.

This species appears to have an Holarctic distribution.

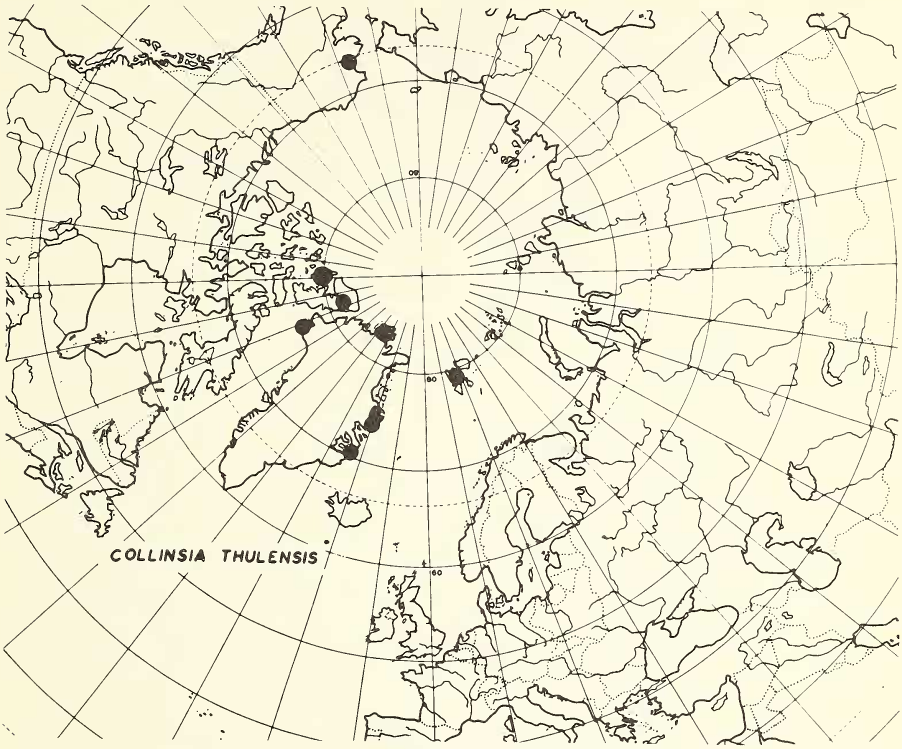


Fig. 15. Distribution map of *Collinsia thulensis*.

*Cornicularia karpinskii *(Pickard-Cambridge) 1873, p. 447 (Figs. 51-53)*

Erigone karpinskii Pickard-Cambridge 1873 p. 447; *C. karpinskii:* Bonnet 1956 p. 1223; Holm 1960a p. 113, b p. 513.

Notes on taxonomy - As suggested by Holm (1958a), *C. karpinskii* seems to be a complex of species whose components are not understood, or else this is a polytypic species. None of the 30 males examined showed any variation in the tibial apophysis, a feature that is variable in some other populations of this species (Holm 1958a, pp. 53, 54). The only observed variable feature in this species was the two lobes of the epigynum, whose proportions of length and width varied slightly.

* Examinations of the holotype of *Cornicularia clavicornis* Emerton (1882, Trans. Conn. Acad. Arts Sci. 6 : 1-86) shows that the Lake Hazen material should be referred to this species. Details will be published later.

Description - Male. Color: carapace pale yellow-brown; eyes ringed with dark brown; legs pale yellow; opisthosoma pale gray-green with four red-yellow spots on the dorsum; sternum golden brown with brown margin; chelicerae golden brown; labium pale brown with gray margin.

Structure: size medium small, entire length about 2.31 mm; carapace distinctly elongate, 0.96 mm long x 0.72 mm wide; carapace gradually rising to the head part, dropping forward and down to the anterior median from the posterior median eyes, then the clypeus drops vertically from the anterior medians; horn placed midway between the anterior and posterior medians, projecting forward and upward, barely, if at all, extending beyond the vertical face of the clypeus; horn with a greater diameter distally than basally; height of clypeus about 3.5 to 4.0 diameters of an anterior median eye; chelicerae vertical or nearly so, perhaps slightly reclined; stridulation organ on lateral sides of chelicerae distinct; eyes equal or subequal in size; posterior row decidedly procurved and all eyes equally spaced at about 1.8 diameters of one posterior median; anterior medians about 0.20 diameters of one apart, and about 0.80 diameters of one from the laterals.

Sternum longer than wide and with a sparse cover of thin hairs; legs not strikingly long or short; tarsal claws with a full complement of teeth, and resembling a comb; the two tibial apophyses of the pedipalp elongate and projecting forward and down atop the cymbium; median apophysis curving down and forward under the lateral, then continuing parallel but ventral to it; median apophysis bifid terminally, one broad, flat, lateral projection with blunt spines pointing outward below and beyond the lateral apophysis, and the other pointed and running parallel to the terminal part of the lateral apophysis; the lateral apophysis curved slightly to the median line, then turned outward at the terminal one-third, ending in a blunt point; the embolus and other parts of the tarsus within the cymbium as in figure 52. Anterior margin of the opisthosoma protruding over the carapace; four small, pale red-yellow depressions on the dorsum of the opisthosoma, the anterior pair closer together than the posterior; average of five measurements of the opisthosoma is 1.35 mm.

Tibia I-II with two spines; tibiae III-IV with one spine each at 0.20 and 0.19 respectively; Tm I about 0.53; Tm II about 0.50; Tm III about 0.47; and Tm IV about 0.31.

Female. Color and structure: Like the male except that the horn is lacking; average length of five females is about 2.55 mm, carapace 0.93 mm, and the opisthosoma about 1.60 mm; tibiae I-III with two spines; tibiae IV with one spine at 0.16 to 0.17; Tm I about 0.46-0.47; Tm II about 0.46 to 0.47; Tm III about 0.47; Tm IV about 0.50.

Natural history - This species is a member of the humid arctic faunal element. It lives in the cracks in the ground and ventures onto the ground surface only when the relative humidity is above 90%. The soil is calcareous with sparse vegetation. The adults and young were found deep in the cracks in the ground where the relative humidity approached 100%. No overwintering sites were found, but I assume that individuals overwinter fairly close to the ground surface.

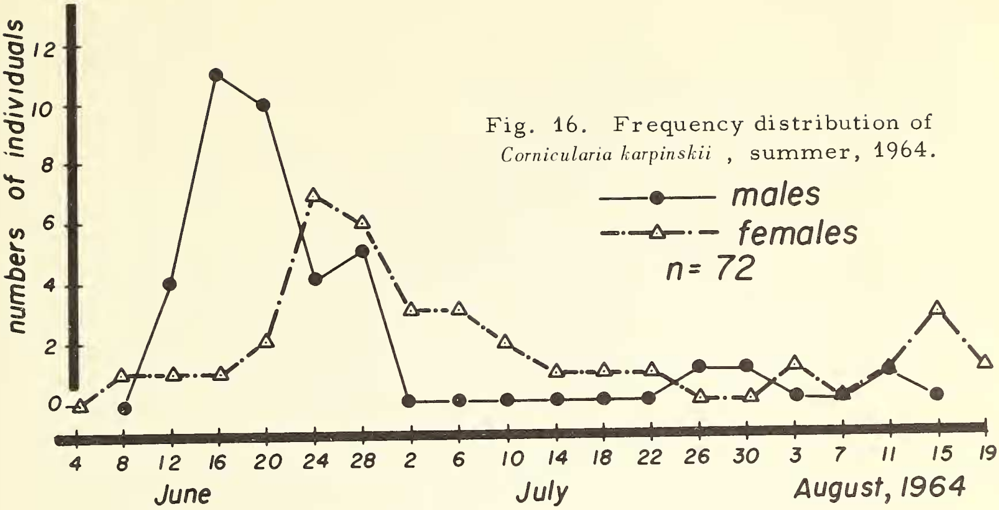


Fig. 16. Frequency distribution of *Cornicularia karpinskii*, summer, 1964.

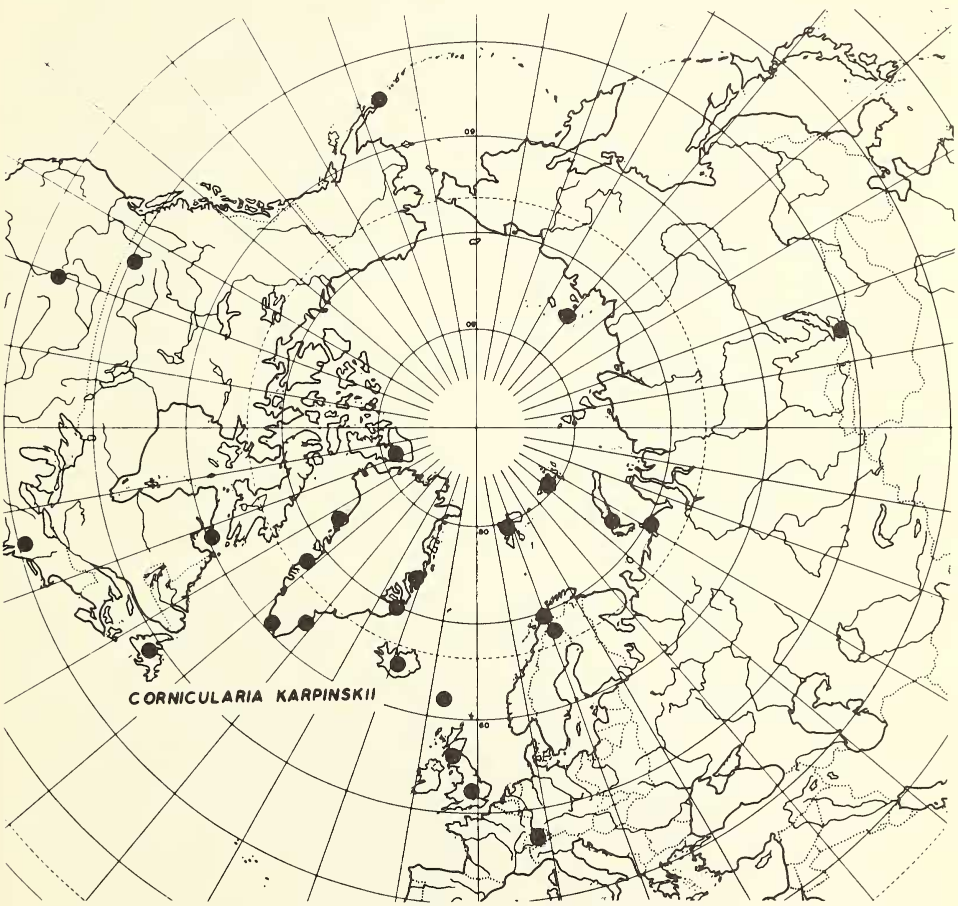


Fig. 17. Distribution map of *Cornicularia karpinskii*.

Figure 16 shows the frequency distribution of this species during the summer of 1964. There are no comparable data from 1963. *C. karpinskii* appears to be able to overwinter in the adult stage, as adults were caught before the spring melt. No parasites or predators were found for this species.

Material examined - About 78 specimens of this species were examined from Hazen Camp, and two from the Aleutian Islands, Alaska.

Distribution (fig. 17) - Unalaska Island and Umnak Island, Alaska. Banff, Alberta. Yellowstone Park, Wyoming. New York. Newfoundland. Akpatok Island, Ungava Bay, N. W. T. Lake Hazen, Ellesmere Island. East and West Greenland. Iceland. The Faeroes. England and Scotland. The Swiss Alps. Northern Scandinavia. Spitsbergen. Franz Joseph Land. Novaya Zemlya. Waigatsch Island. Lake Baikal, Siberia. Kamchatka.

This species is circumpolar in distribution, though, as mentioned in the notes on taxonomy, it is not certain that this distribution represents only one species.

Erigone psychrophila *Thorell, 1872 a p. 689 (Figs. 42-44)*

E. psychrophila: Bonnet 1956 p. 1772; Holm 1958a p. 52, b p. 532, 1960a p. 116, b p. 513; Braendegaard 1960 p. 12; Oliver 1963 p. 176.

Natural history - This species is a member of the humid arctic faunal element. *Erigone psychrophila* is restricted to vegetated, marshy areas at the edges of ponds and quiet streams and to water-saturated, vegetated slopes. These data do not quite agree with Holm (1958a, p. 53) who states that *E. psychrophila* belongs to both the dry and humid faunae. The species apparently overwinters in the vegetation and can often be found moving under water in the slush snow during the spring melt.

Figure 18 shows the main activity period and summer distribution in numbers. The males are very active during the mating season, then are scarce thereafter. The sharp drop in the number of females caught in early July can be attributed mostly to the females secluding themselves while egg laying. The drop-off in early August might be attributed to death of the females and to inactivity because of cool weather. The adults are apparently able to overwinter as they are found at the very beginning of the season.

No parasites or predators of this species were found, but I assume that as in the case of all these small spiders, they are prey to the larger spiders.

Material examined - About 1983 adult specimens of this species were examined from Hazen Camp, nine females, three males and six immatures from Cornwallis Island (Leonard Hills, collector, 1964), one male from Thule, Greenland (personal collection, 1964), 355 adult specimens from Melville Island (Larry Law, collector, 1964), and one male, one female and one immature from Mould Bay, Prince Patrick Island (J. E. H. Martin, collector, 1965).

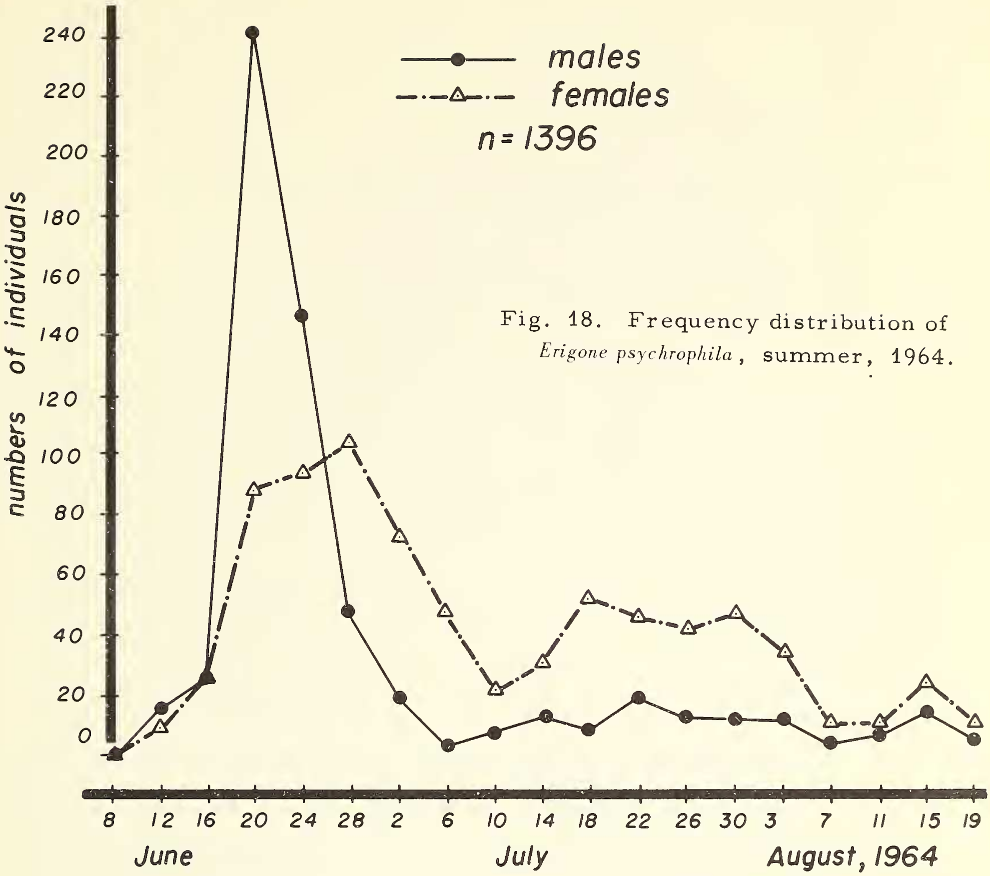


Fig. 18. Frequency distribution of *Erigone psychrophila*, summer, 1964.

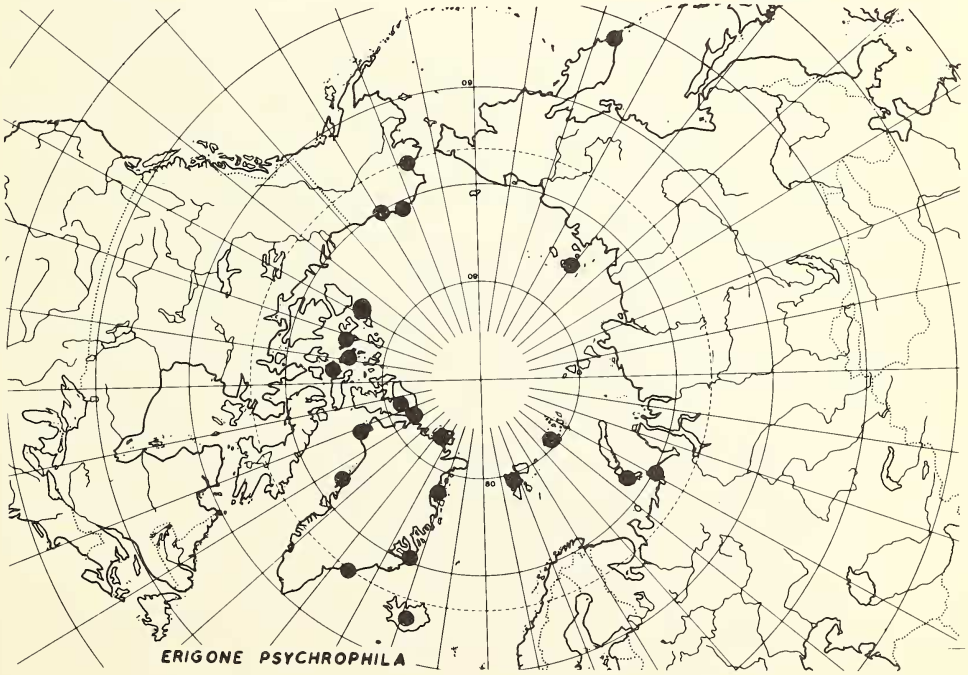


Fig. 19. Distribution map of *Erigone psychrophila*.

Distribution (fig. 19) - Coastal Alaska (Arctic and Bering). Weatherhall Bay, 75°46'N, 106°56'W), Melville Island. Mould Bay, Prince Patrick Island. Marie Bay, Bathurst Island. Cornwallis Island. Alert and Hazen Camp, Ellesmere Island. Greenland (Peary Land; East Greenland, 67-77°N; West Greenland, 74-77°N). Iceland. Spitsbergen. Northern Scandinavia. Novaya Zemlya. Waigatsch Island. Franz Joseph Land. New Siberian Islands. Kamchatka. This species is circumpolar in distribution.

Hilaira vexatrix *(Pickard-Cambridge) 1877, p. 280 (Figs. 15, 16)*

Erigone vexatrix Pickard-Cambridge 1877 p. 280. *Hilaira vexatrix:* Bonnet 1957 p. 2214; Holm 1958b p. 532; Braendegaard 1960 p. 14.

Notes on taxonomy - Schenkel (1950) lists a record of this species from Banff, Alberta. Without seeing the Alberta specimens, I cannot agree that this species has anything but a high arctic distribution. Holm (1956) does not list Schenkel's reference, nor does he give any comment about an Alberta record. All previous records for this species are above 70°N latitude.

Natural history - This species is a member of the humid arctic faunal element, as it is found only in damp, vegetated regions that are rarely, if ever, inundated. Many specimens were collected in the damp, upper edges of ponds and small streams that have dense vegetation and many rocks under which they may crawl to overwinter. Specimens of *Hilaira vexatrix* overwinter under rocks and in cracks in the ground about one to two cm deep. They are active on the ground as soon as the ground temperature is above freezing, even though the air temperature is well below freezing.

Figure 20 shows the activity periods of this species during the summer. The June 16 to 24 peak is the period of courting and mating, and the peak at the end of the season is the increase of adults that will overwinter. Therefore, the peaks belong to two distinct populations of adults. The adults of this species overwinter.

Neither courtship nor mating were observed in this species; the males died about five days after mating.

On June 15, 1964, two females laid eggs which were in small, lenticular, white egg sacs. On June 18, a third female laid eggs. The egg sacs were suspended in tangle webs about one cm above the ground. The females remained with the eggs until after the young had emerged. One of the females ate the male after mating.

On July 3, the small spiders were visible inside the egg sacs, and on July 12, the young from the eggs laid on June 15 emerged. On July 20, the young from the third sac emerged. The three sacs contained 9, 11, and 8 eggs respectively. The egg sacs were kept at a constant 100% relative humidity.

The females did not feed and were not fed for a period of six weeks, and at the end of this period showed no signs of stress. Collembola were introduced as food, but the females showed no interest. All three females were dead by August 10.

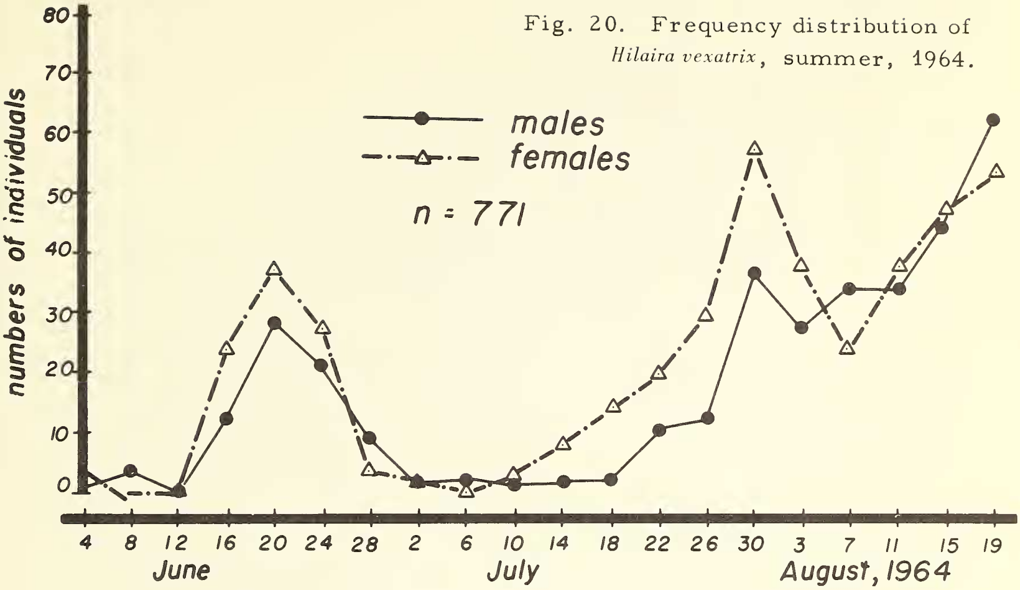


Fig. 20. Frequency distribution of *Hilaira vexatrix*, summer, 1964.

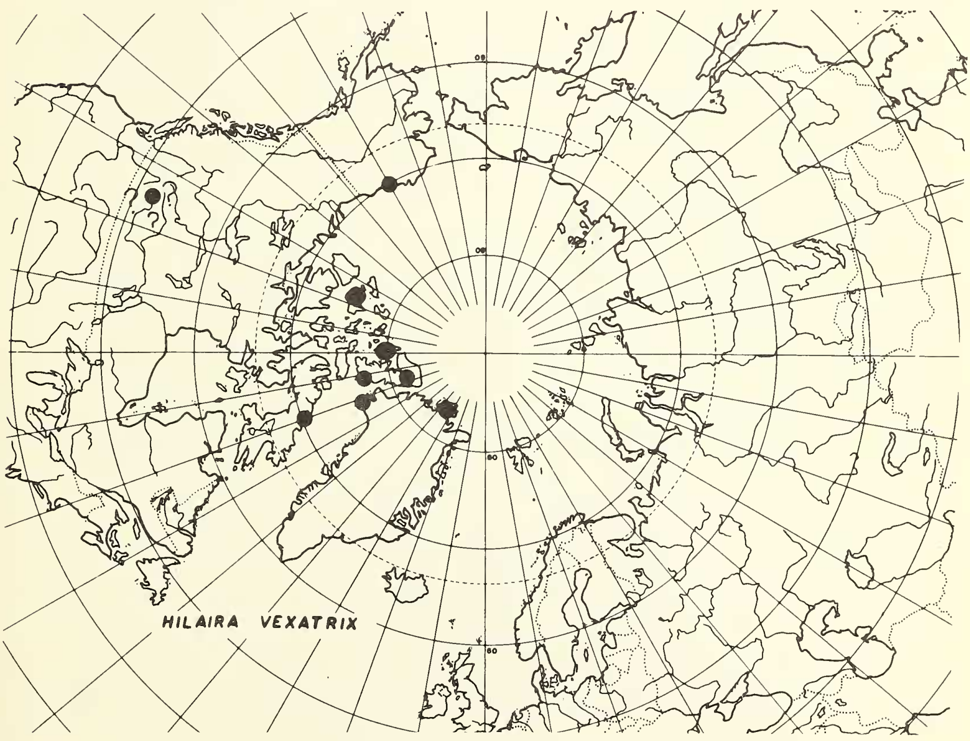


Fig. 21. Distribution map of *Hilaira vexatrix*.

No parasites or predators of this species were found. A great number of the immatures die by cannibalism.

Material examined - About 2159 adults of this species were examined from Hazen Camp, two males and eighteen females from Thule, Greenland (personal collection, 1964) 63 males and 91 females from Axel-Heiberg Island (Heinz Rutz, collector, 1963), and one male, 18 females and 17 immatures from Melville Island (J. E. H. Martin, collector, 1965).

Distribution (fig. 21) - Greenland (Peary Land; Thule). Ellesmere Island (Alert; Hazen Camp; Discovery Harbour). N. E. Coast of Baffin Island. Axel-Heiberg Island. Melville Island. Arctic Coast of Alaska. Banff, Alberta (?).

This species is Nearctic. The chances of it being found in the Palearctic Region are slight, as Braendegaard (1958) has studied the Iceland material, Locket and Millidge (1951, 1953) have studied the British material and Wiehle (1956, 1960) has studied the German material.

*Meioneta nigripes *(Simon) 1884, p. 439 (Figs. 62-64)*

Microneta nigripes Simon 1884 p.439. *Meioneta nigripes*: Bonnet 1957 p. 2756; Braendegaard 1958 p. 80, 1960 p. 15; Holm 1958a p. 56, 1960 b p. 513.

Natural history - This species is a member of the humid arctic faunal element. Individuals live deep in soil cracks or under medium to large-sized stones on very dry south- to southwest-facing slopes. That is, the macroclimatic conditions are dry, but the microclimatic conditions are humid. Braendegaard (1946, 1960) considers this species to be euryoequous (euryecious), but examination of the microclimate leaves no doubt that it is a humid arctic species.

Overwintered adults were collected on June 1, 1964, before the spring thaw. Inactive females were collected from under rocks that were frozen to the ground surface. These females became active within ten seconds of the time they were collected and exposed to the sun. Figure 22 shows the peak of activity for the species at the beginning of the season.

Courtship was observed in several pairs of this species and no variation was seen. Observations were started on June 1, 1964. Males and females were placed in a small bottle with soil and rocks. Random wandering was observed for several hours, after which time the males selected areas that they would mildly defend. These were small areas in which each male had built a small, horizontal, almost invisibly-thin sheet web about 2 x 4 mm, and from which the males hung upside down. Each male remained on this sheet for about 15 minutes. These were, I believe, the sperm webs, though no sperm droplets were seen. Eventually, each male searched for and built a small tangle web near a female. When the web was built, each male began a combination of activities as follows: each palpus was jerked forward and back alternately, much like two pistons. At the same time, the whole body was jerked back and forth. Coordinated with these was a gradual approach towards the female. About three mm from the female, the male began body-jerking and strumming one front foot, then the other. Then the female started the same sort of

* Examinations of the holotype of *Meioneta maritima* (Emerton) New combination (1919, Rep. Can. Artic Expedition 1913-18, 3 : 4H) shows that the Lake Hazen material should be referred to this species.

motions. When their front legs touched, the female fled with the male in jerky pursuit.

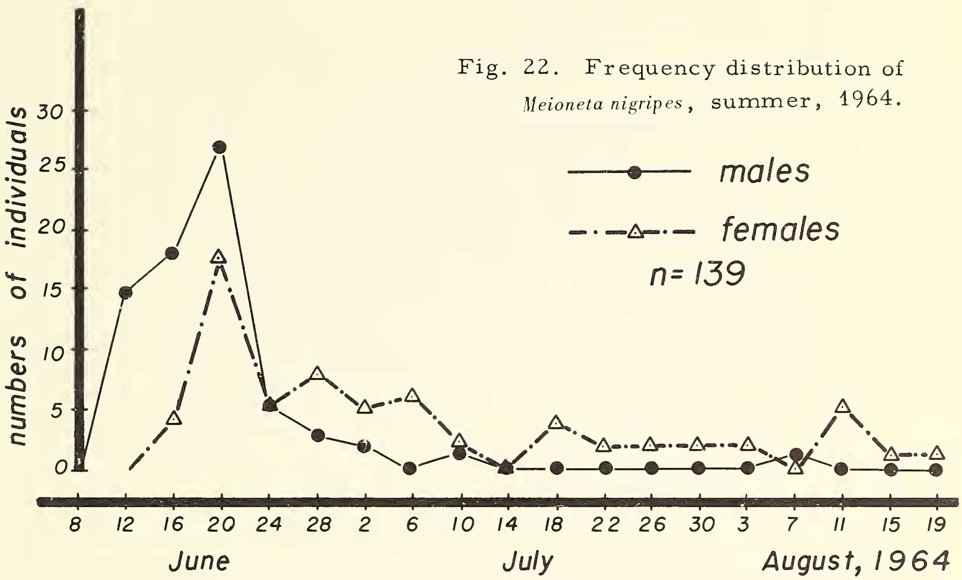


Fig. 22. Frequency distribution of *Meioneta nigripes*, summer, 1964.

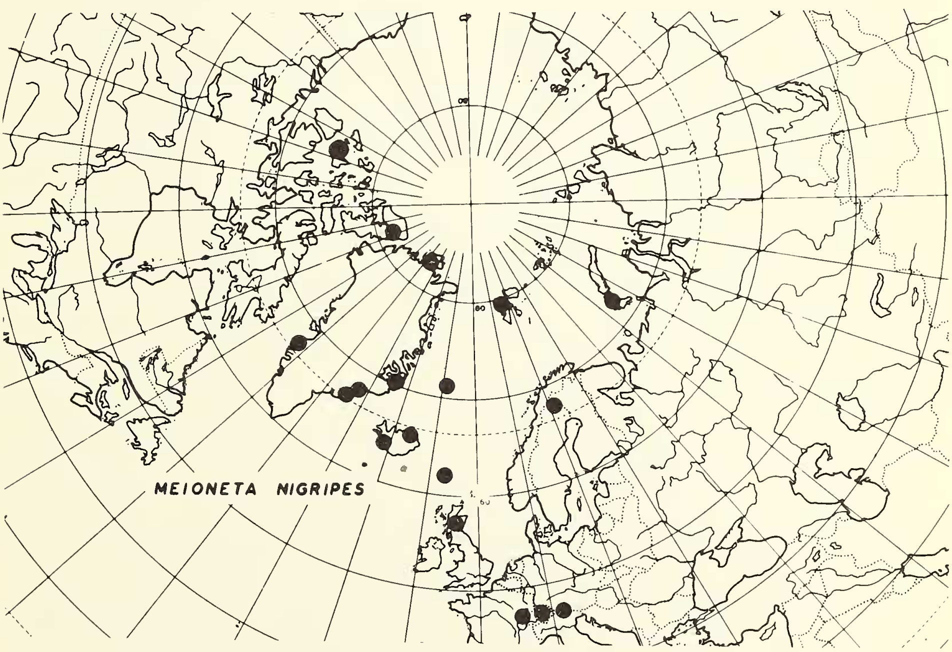


Fig. 23. Distribution map of *Meioneta nigripes*.

During the next 45 minutes, the males and females engaged their front legs for brief moments, then broke contact. At 90 minutes, one of the females built a small tangle and sheet web, then hid in one corner of the web. In a few minutes, the female was found by the male. The male began improving the web and the two finished the preparations in eight minutes. The web was made while both were upside down.

At this point the male and female stopped and remained still for five minutes. Gradually, with increasing vigour, the male began jerking in the web, and shortly after the female began strumming. Slowly, the male stopped jerking and began strumming, and approached the female as he did so. Then the palpi began pushing back and forth like pistons. (Both spiders were still hanging upside down from the sheet web.) When their legs touched, the female did not scurry away, but relaxed the front two pairs of legs so that the prosoma hung down from the web.

In mating, the male came forward so that his carapace touched the sternum of the female. At the same time, the right palpus shot forward, grappled with the epigynum, and lifted part of it away. The haematodocha expanded and the embolus twisted spirally into the spermathecal duct. The right palpus was engaged for one second, then the left palpus was applied for the same length of time. During the next 18 min 25 sec the male alternated the palpi 380 times. At no time was the male held captive by the female.

The male left the female for 40 seconds and retired to a small corner of the web where possibly the sperm were replenished in the palpi. The male then rejoined the female and during the next 6 min 41 sec, alternated the palpi 150 times before again returning to the corner to replenish the sperm. Returning to the female, the male again alternated the palpi on the epigynum, but now more slowly. In 6 min, only 40 alternations; at 11 min, only 6 more times; and in the last 33 min, the palp were alternated 37 more times. The last 6 couplings took about two min each. The female effected the finish. Shortly thereafter, the two fled in opposite directions.

More pairs were observed mating. The females seemed to be eager to mate several times with any male and often tried, but no male could be persuaded to engage a female - any female - more than once.

Four days after mating on June 5, 1964 two females laid eggs in small, round, white egg sacs. The egg sacs were attached directly to the side of the container. As with *H. vexatrix*, the eggs were kept in 100% relative humidity. More eggs were laid by other females on July 12 and August 24.

On July 3, 1964, eight young emerged from each egg sac laid on June 5. During the development of the eggs, the females stayed within two to three cm of the eggs.

On July 12, Collembola were introduced to the females and young for food. The females fed immediately. I also observed that females captured and bit several Collembola, leaving them inactive in the tangle web about the egg sac, and later returned to feed on them. The young spiders appeared to be too small to feed on Collembola. Most of the young died by cannibalism. The females of this species refused to eat anything but Collembola and Acarina, even though they were offered small Diptera and spiders. No parasites or predators of this species were found.

Material examined - About 157 adults of this species were examined from Hazen Camp, and one male and 13 females from Bailey Point, Melville Island (J. E. Martin, collector, 1965).

Distribution (fig. 23) - Ellesmere Island (Hazen Camp). Bailey Point, Melville Island. Greenland (Peary Land; W. Greenland at 63°N; E. Greenland from 63-70°N). Iceland. Spitsbergen. Jan Mayen Island. The Faeroes. Scotland. North Sweden. Novaya Zemlya. The French, Swiss, and Tyrolian Alps.

This species is mainly Palearctic in distribution, but the Hazen Camp record makes it Holarctic. Judging from the known distribution, it is likely to be found across the high Nearctic.

Minyriolus pampia *Chamberlin, 1918, p. 539 (Figs. 47-50)*
M. pampia: Oliver 1963 p. 176.

Notes on taxonomy - Previous to the collections made at Hazen Camp, this species was known only from one male from Clyde River, Baffin Island. In 1963 and 1964, about 520 males and females and an unknown number of immatures of this species were collected. I have redescribed the male and have provided illustrations. The female is here described and drawn for the first time.

Description - Female. Color: carapace brown, splotched and streaked with dark brown; chelicerae yellow-brown; sternum brown; labium brown, but rimmed with gray; coxae of pedipalpi yellow brown, but gray at the gnathobases; legs and pedipalpi yellowish brown, flecked with gray-black spots near the joints; opisthosoma ovate, pubescent, gray-black with fine green streaks and four small reddish spots on the dorsum; spinnerets brown.

Structure: carapace rounded, cephalic region slightly elevated; height of clypeus about 3.5 diameters of an anterior median eye; eyes small; posterior row slightly procurved; posterior medians about 2.0 diameters of one apart, and about 1.5 diameters of one from the posterior laterals; anterior row almost straight; anterior medians about half of an anterior lateral in size.

Anterior medians about one diameter apart, and each about 1.7 diameters from the anterior laterals; median ocular quadrangle longer than wide and wider behind than in front; chelicerae reclined; sternum only slightly longer than wide, and separating the hind coxae by almost the length of one.

Total body length 1.85 ± 0.15 mm; carapace length 0.62 ± 0.03 mm; carapace width 0.59 ± 0.02 mm; legs moderately short, metatarsi slightly longer than tarsi; pedipalp tarsus lacking a spine or claw at the tip; metatarsi each bearing one long trichobothrium at 0.74 or 0.75 ; tibiae I-III with two spines, tibiae IV with one spine.

The color and structure of the male are like those of the female, except for the following points. Total length 1.59 ± 0.11 mm; carapace length 0.63 ± 0.01 mm; carapace width 0.61 ± 0.02 mm; tibiae I-III with two spines, tibiae IV with one spine; Tm IV at 0.78.

Natural history - This species is a member of the humid arctic faunal element. It was found only on densely-vegetated slopes which are permanently water-saturated, and which are south- and southwest-facing. It is further restricted to the night shadow area.

Figure 24 shows the main period of activity of the males of this species. I am not able to explain the higher peak of the females which coincides with the peak of the males. Adults apparently overwinter as they were found in the slush ice at spring melt. No parasites or predators of this species were observed.

Material examined - About 581 adults of this species were examined from Hazen Camp. The holotype was not seen.

Distribution (fig. 25) - This species is known only from Hazen Camp, Ellesmere Island, and River Clyde, N.E. Baffin Island, N.W.T., Canada (70°N, 70°W).

Savignya barbata *(Koch), 1879, p. 60 (Figs. 58-61)*

Erigone barbata Koch 1879 p. 60. *Savignia barbata:* Roewer 1942 p. 623. *Typhochraestus barbatus:* Bonnet 1959 p. 4745.

Notes on taxonomy - The spelling of the generic name should be "*Savignya*", not "*Savignia*". The genus was named after Jules César Savigny, a French biologist of the early 19th Century, by Blackwall (1833).

Description - Female. Color: carapace brown with dark brown markings; chelicerae pale yellow with a brownish tint; sternum dark brown; legs pale yellow-brown with small brown splotches; opisthosoma gray-black with four small pale gray to reddish spots on the dorsum; spinnerets brown; coxae brown, gnathobases gray; labium brown with gray trim.

Structure: size small, about 1.80 mm long; carapace broad and rounded, slightly longer than wide, 0.62 mm long x 0.57 mm wide; carapace raised behind the cephalic region, and sloping down to the eyes; one anterior median eye about 0.5 diameters of a lateral; anterior row in a straight line; anterior medians about two diameters of one from the laterals; posterior row slightly procurved; posterior medians slightly more than two diameters of one apart, and about two diameters of one from the laterals; posterior eyes equal or subequal in size; median ocular quadrangle wider posteriorly than anteriorly; posterior medians about as far apart as the quadrangle is long.

Chelicerae reclined; sternum wider than long, proportions are 2.1 : 1; legs moderately short; tibia I-II with two spines, tibia III-IV with one spine; Tm I about 0.52; Tm II about 0.46; Tm III about 0.42; Tm IV lacking.

The male is like the female in color and structure except for the following features. Size small, about 1.68 mm long; carapace rounded, 0.62 mm long x 0.62 mm wide; carapace raised into a cephalic lobe; cephalic pits opening out to horizontal grooves that run posteriorly the full length of the cephalic lobe.

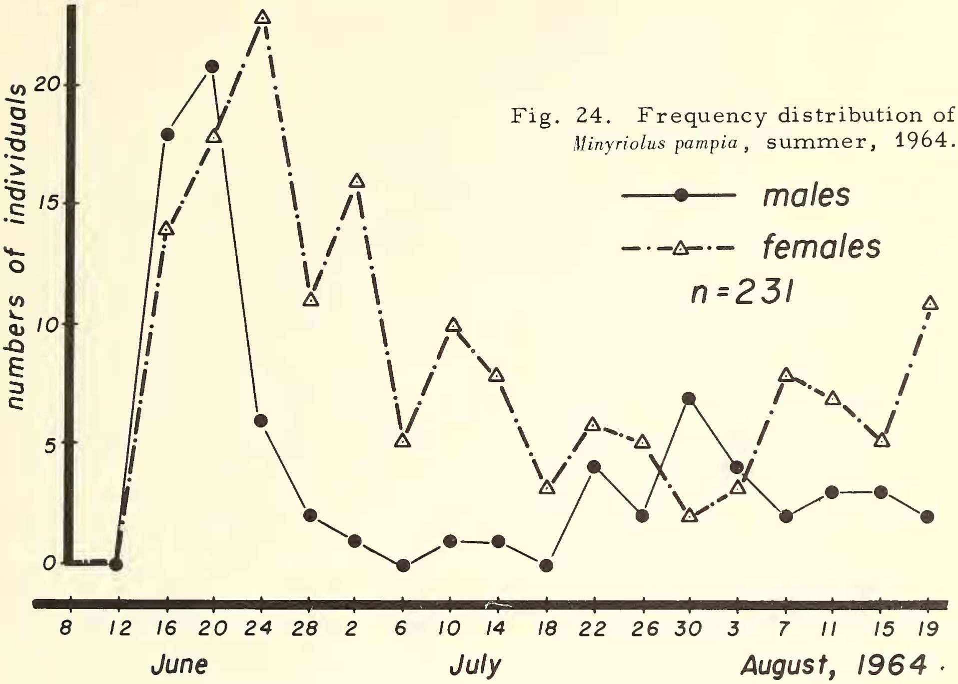


Fig. 24. Frequency distribution of *Minyriolus pampia*, summer, 1964.

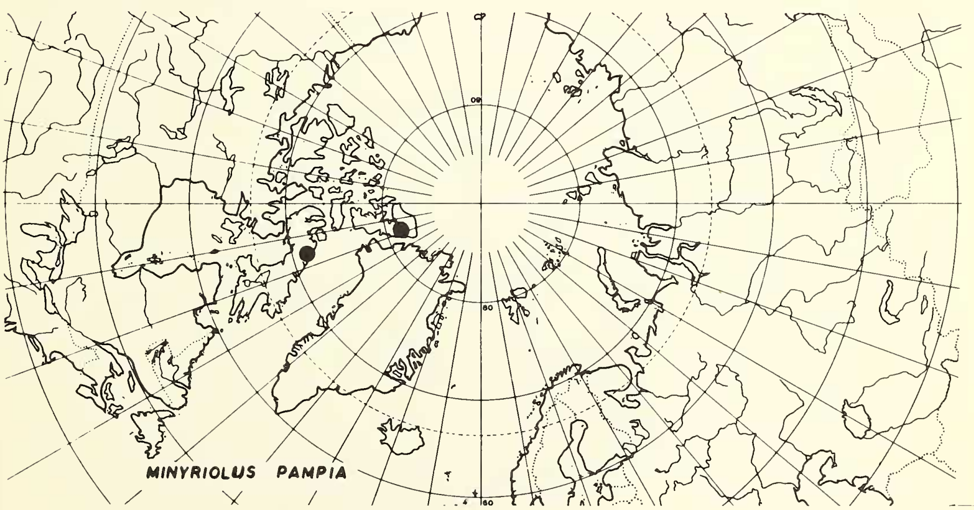


Fig. 25. Distribution map of *Minyriolus pampia*.

Eyes small; posterior row decidedly procurved; posterior medians at the top front edge of the cephalic lobe and almost five diameters of one from the laterals; laterals about two diameters of a median in size; anterior and posterior laterals on a small, common tubercle.

Clypeus height about ten diameters of an anterior median eye; clypeus pubescent with short, stiff, straight, pale-colored hairs; tibia I-II with two spines; tibia III-IV with one spine; Tm I about 0.58; Tm II about 0.54; Tm III about 0.50; Tm IV lacking.

Natural history - This species is a member of the humid arctic faunal element. It was found only in the gravelly sections of river deltas with scattered surface vegetation. The webs are built in the cracks in the ground and rarely on the surface. It appears to overwinter on or near the surface under rocks and in vegetation.

Figure 26 indicates the most active period of the summer season for the males. It is not known if the adults overwinter.

Material examined - About 100 adults of this species were examined from Hazen Camp, one female from Thule, Greenland (personal collection), two females from Bailey Point, Melville Island (J. E. H. Martin, collector, 1965), five males and five females from Weatherhall Bay, female from Axel-Heiberg Island (Heinz Rutz, collector, 1963).

Distribution (fig. 27) - Siberia (exact locality I could not find). Novaya Zemlya. Spitsbergen. Greenland (Etah, and Thule). Ellesmere Island (Hazen Camp). Melville Island. Axel-Heiberg Island. This species is Holarctic in distribution, but it is known only from the high arctic.

Typhochraestus latithorax *(Strand), 1905 (Figs. 54-57)*

Tarsiphantes latithorax Strand 1905 p. 23; *T. latithorax:* Bonnet 1959 p. 4262; *Typhochraestus latithorax*: Holm 1960b p. 511.

Notes on taxonomy - In 1905, Strand erected the new genus *Tarsiphantes*, with the one species, *latithorax*. The species was described from one damaged female and one subadult female. Holm (1960) synonymized *Tarsiphantes* Strand, 1905, as a junior synonym of *Typhochraestus* Simon, 1884, based on a study of the holotype of *latithorax*. The holotype had in the meantime become dried and even more damaged than when Strand described it.

The genus *Typhochraestus* is determined and defined by the characters of the palpus of the male, which has a large, spiral embolus with a small, somewhat spiral basal apophysis (see Holm 1943, and Wiehle 1960). The males of *latithorax*, here described and figured for the first time, have these features.

Strand reports (1905, p. 23) that "Diese neue Gattung, deren Type und einzige Art die neue *T. latithorax* Strand ist, ... wurde am Rice Strait, 30/6 1898 entdeckt . . . .". However, the ship "Fram" did not reach Rice Strait until at least August 17, 1898, so either the year or the month is in error. During June 1899, Dr. Johan Svenden, the "Fram's" doctor, did some collecting at Fort Juliana (79°03'N, 77°43'W). About August 12, 1899, the "Fram" left the Rice Strait for Payer Harbour, and later Jones Sound (Bryce 1910, p. 245). Thus, it is more likely that Fort Juliana is the actual collecting site for this species. Rice Strait (78°34'N, 74° 45'W) is close to Fort Juliana.

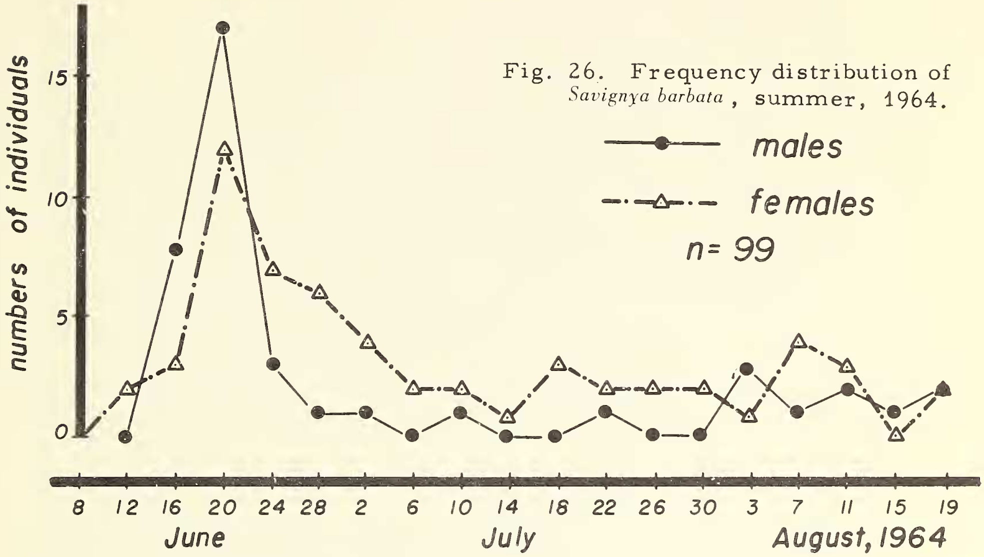


Fig. 26. Frequency distribution of *Savignya barbata*, summer, 1964.

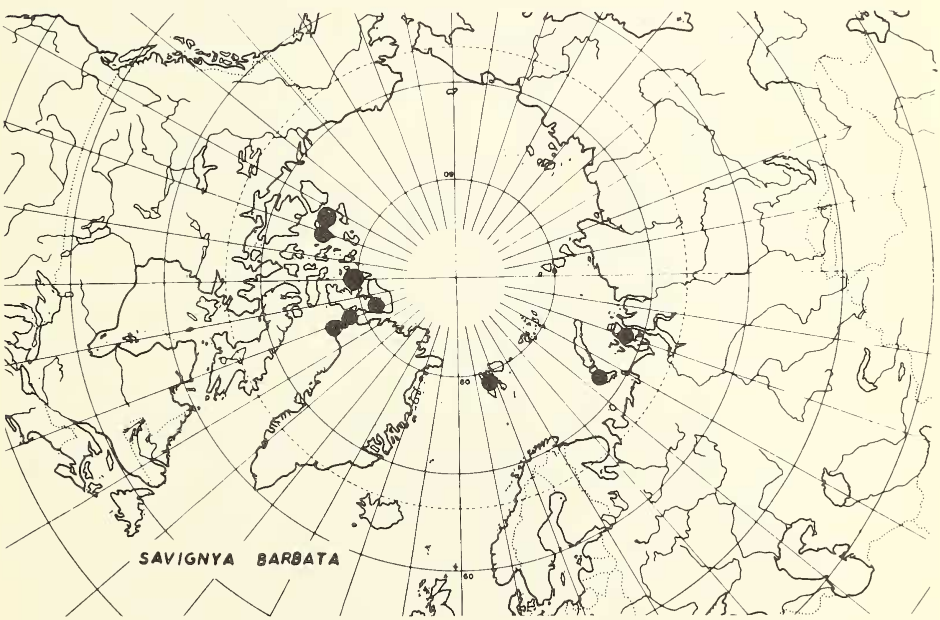


Fig. 27. Distribution of *Savignya barbata*.

Description - Female. Color: carapace brown, marked and shaded with dark brown; chelicerae brown; sternum brown; labium brown, but marked with gray; coxae of pedipalpi brown, but gnathobases gray; legs pale brown-yellow, distal part of each leg segment brownish; opisthosoma brown-gray; spinnerets brown-gray.

Structure: size small, about 1.90 mm total length; carapace longer than wide, 0.64 mm long x 0.54 mm wide, carapace broad and rounded, gradually rising to the low cephalic region; clypeus height about five diameters of an anterior median eye; posterior row of eyes slightly procurved; posterior medians about 1.5 diameters of one apart, and closer to the posterior laterals than to each other; anterior row of eyes slightly procurved; anterior medians less than the diameter of one apart, and about the diameter of one from the laterals; anterior laterals almost twice the size of an anterior median; median ocular quadrangle about as wide at posterior medians as long; chelicerae decidedly reclined; sternum about as wide as long; legs moderately long; metatarsus IV about 1.45 times longer than tarsus IV; tibia I-III with two spines, tibia IV with one spine at 0.29; Tm I about 0.63; Tm II about 0.54; Tm III about 0.48; Tm IV lacking.

Male. The male is colored like the female. Structure: size small, about 1.45 mm; carapace longer than wide, about 0.64 mm long x 0.54 mm wide; carapace structure like that of the female, except for a small, post-ocular sulcus and lobe that is finely-bridged and connecting behind each posterior median eye (see figures 55, 56); metatarsus IV about 1.29 times longer than tarsus IV; tibia I-III with two spines, tibia IV with one spine; Tm I about 0.56; Tm II about 0.53; Tm III about 0.50; Tm IV lacking. For the characteristic details of the pedipalp of the male, see figure 54.

Natural history - This species is a member of the humid arctic faunal element. The species is widely distributed throughout soggy, vegetated areas at and near pond edges, but is restricted to the night shadow areas. Individuals have been collected under water in slush snow at the time of the spring melt, and on wet, south-facing slopes and depressions abounding with sedges or mosses.

Figure 28 shows the abundance pattern of the species during the summer of 1964. It is not known if the adults overwinter, but it can be assumed that they do as the adults are found so early in the season.

Material examined - About 100 adult individuals of this species were examined from Hazen Camp and four males and two females from Axel-Heiberg Island (Heinz Rutz, collector, 1963). The holotype was not seen.

Distribution (fig. 29) - This species is known from three localities only, two on Ellesmere Island at Hazen Camp and either Rice Strait (78° 34'N, 74°45'W) or Fort Juliana (79°03'N, 77°43'W), and Axel-Heiberg Island.

Xysticus deichmanni *Soerensen, 1898 p.228 (Figs. 10, 11)*
X. labradorensis: Bonnet 1959 p.4883 (in part); *X. deichmanni:* Holm

1958b p. 533, Buckle and Redner 1964 p. 1139, Oliver 1963 p. 176, Turnbull, Dondale, and Redner 1965 p. 1263.

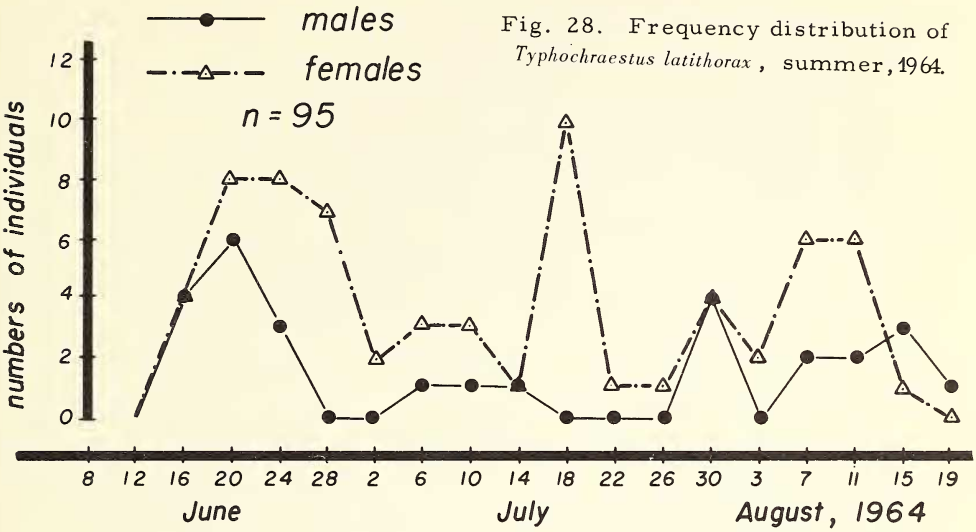


Fig. 28. Frequency distribution of *Typhochraestus latithorax*, summer, 1964.

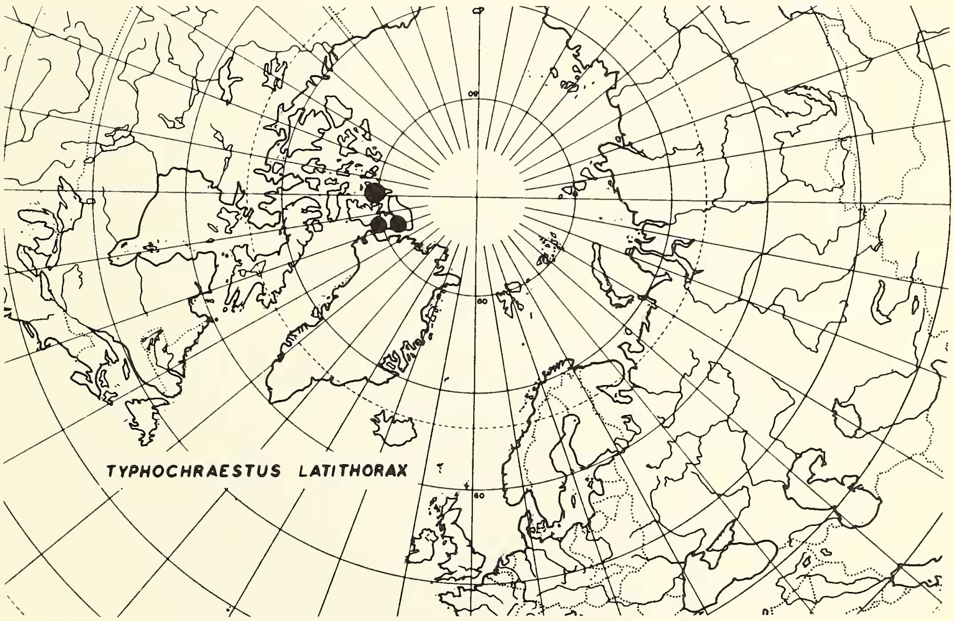


Fig. 29. Distribution of *Typhochraestus latithorax*.

Notes on taxonomy - Holm (1958b) and Buckle and Redner (1964) have distinguished the species *labradorensis* from *deichmanni*. The distribution records of the two species do not overlap.

Natural history - This species is a member of the arid arctic faunal element. Individuals at Hazen Camp were found with *Dictyna borealis* under and around *Dryas integrifolia*. The main difference observed about the habitat of the two species is that *X. deichmanni* remains mostly on the ground under and beside vegetation (occasionally in the *Dryas* flowers), whereas *D. borealis* is mostly on and in the vegetation. *X. deichmanni* was found mainly under and near *Dryas integrifolia* clumps, but occasionally near *Salix arctica* and *Kobresia myosuroides*.

Figure 30 shows the occurrence of the adults of this species during the summer of 1964. Data from 1963 are almost identical. The adults are able to overwinter, as is indicated by the late season increase.

The Thomisidae have little or no courtship preceding mating (Kaston 1936), and *Xysticus deichmanni* is no exception. In all four cases observed, the males mounted the females after a short contact or mounted directly upon contact without any hesitation. The females offered no resistance to any of the males. Once upon the females, the males tied down the females with silk. Silk threads were attached from the carapace to the patellae to the ground and back again many times. Once the female was thoroughly tied down, the male began to mate.

Before the actual mating, the male appeared to clean and polish the palpi in the chelicerae. Each palpus was very carefully rubbed and manipulated. When this was done, the male crawled back along the female, then around and under the posterior end of the opisthosoma of the female, then mated by alternately placing the palpi upon the epigynum. When mating, the pair are positioned venter to venter and facing the same direction (see Kaston 1936). The duration of the matings were 5, 52, 55.5 and 59 min each. In the case lasting five min, the male was successful in placing each embolus within the epigynum once before leaving the female. In the remaining cases, each palpus was placed on the epigynum for an average of about 14 min. The haematodocha was refilled and embolus re-inserted once every 20 sec. When the haematodocha refilled, the large dorsal and some smaller lateral spines on the legs of the male became erect for about two sec, then gradually over the next three sec, relaxed.

When the male was finished mating, he again crawled onto the dorsum of the female, polished the palpi in the chelicerae, paused, then fled rapidly. The males died about four days later.

As of October 8, 1964, no eggs were laid. Thus it can be assumed that the fertilized females overwinter and lay eggs in the following summer. Gertsch (1964, pers. comm.) has confirmed this. Sometime between October 8 and 18, 1964, eggs were laid in a small sac on the flat edge of a rock. There were 28 eggs. The sac was lenticular, about six mm in diameter, and about two mm in thickness in the centre.

The main food for the species seems to be small Diptera, especially Chironomidae and Culicidae. Oliver (1963, pers. comm.) found several instances where this species was feeding on the first instar larvae of

Gynaephora rossi Curtis and *G. groenlandica* (Hom.)(Lymantriidae, Lepidoptera) as they emerged from the eggs on the cocoon of the female. The first instar larvae are only about one mm long, and present no difficulty in grasping for the spider. Oliver (pers. comm.) and I have also found specimens hiding in *Dryas* flowers, presumably to catch visiting insects.

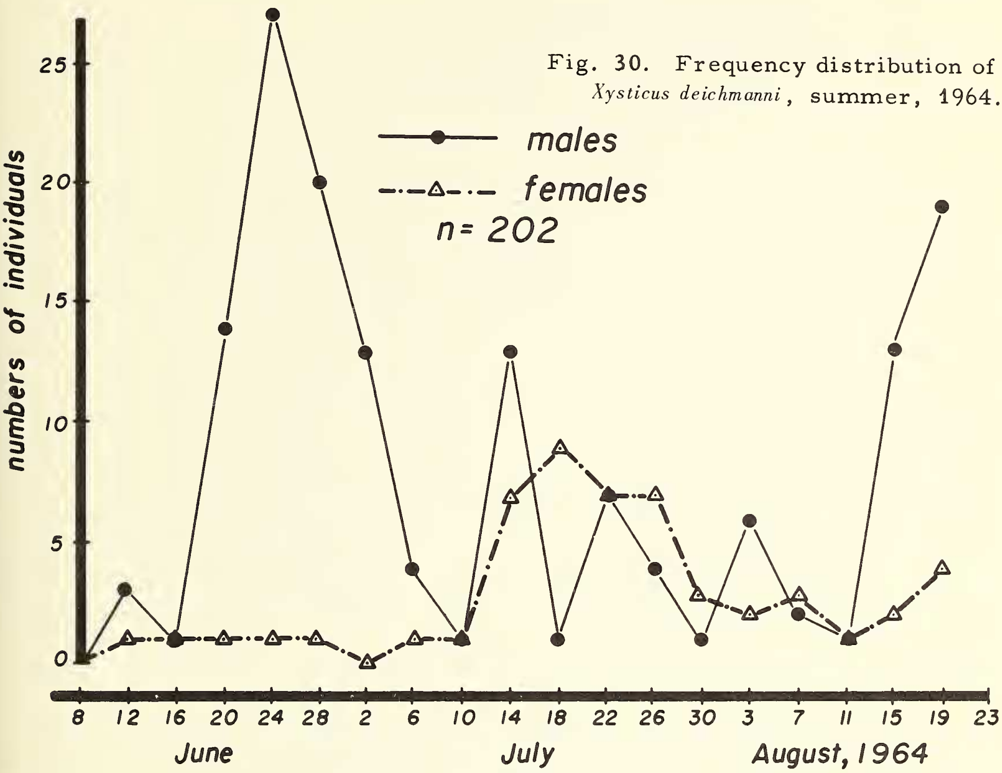


Fig. 30. Frequency distribution of *Xysticus deichmanni*, summer, 1964.

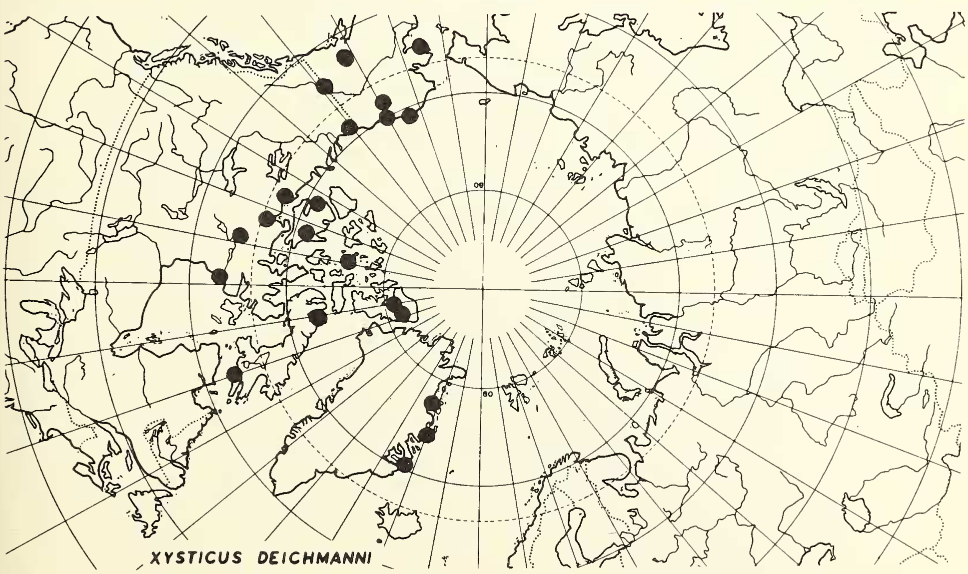


Fig. 31. Distribution map of *Xysticus deichmanni*.

In 1963, one female was found with a parasite, *Hexamermis* species (Nematoda, Mermithidae), inside the opisthosoma. The epigynum was abnormal, indicating parasitic castration within.

The contents of the crop and gizzard of two snow buntings showed remains of legs and carapaces of *X. deichmanni*. There were also many observed cases of cannibalism.

Material examined - About 575 adults of this species were examined from Hazen Camp, and one male and one female from Chesterfield Inlet, N. W. T., and two females from Tanquary Fjord, Ellesmere Island (Guy Brassard, collector, 1964).

Distribution (fig. 31) - Greenland (N. E. Greenland between 70-78°N). Canada (Franklin District: near Ukpilik Lake, King's Bay, and Holman Island, Victoria Island; Hazen Camp and Tanquary Fjord, Ellesmere Island; Moose Bay, Bathurst Island; Lake Harbour, Baffin Island; mouth of the Aktinek River, Bylot Island, 70°N, 78°W; Keewatin District; N. W. side Aberdeen Lake; Chesterfield Inlet; Mackenzie District: Bathurst Inlet; Coppermine; Bernard Harbour; Yukon Territory: Firth River, 16 miles from the Arctic coast; Swede Dome, 34 miles W. Dawson City). Alaska (Mile 206, Richardson Highway; Nome; Point Barrow; Umiat; Meade River; and Cooper Landing).

Notes: Buckle and Redner (1964, p. 1141) record the Richardson Highway as being in the Yukon. This locality is really in Alaska, 206 miles north of Anchorage. The Holman Island locality referred to by these authors is most likely the townsite of Holman Island on Victoria Island, not the very small island off shore near the town. King's Bay, Victoria Island, for all intents and purposes, is the same locality as Holman Island.

ZOOGEOGRAPHICAL CONSIDERATIONS

In 1934, Gelting, after an analysis of the botanical and geological evidence, proposed that the northeastern tip of Peary Land was ice free during the maxima of the ice ages, and that some other areas on Greenland were ice free during at least the Wisconsin Glaciation. The idea of ice free areas or "refugia" in Greenland was not his though, as Kornerup (1878) proposed this after a geological study, and Warming (1888) again, after a botanical study. Heated controversy for and against the theory of glacial refugia has occurred since then and the subject is still being debated (Ball 1963, Lindroth 1963a, Benson 1958, Nordhagen 1963).

In 1937, Eric Hultén published a monumental work on phytogeography in the arctic and boreal regions based on the premise of glacial refugia. Since then, most biologists agree that ice-bound refugia existed during glacial times (Savile 1961; Packer 1962, various authors in Löve and Löve 1963, various authors in Lowther 1959, 1962, Lindroth 1957, 1961, 1963a, 1963b, Larsson 1959, Harington 1964, Hammer 1955, Böcher *et al.* 1957, Ball 1963, McPhail 1961).

The basic premise upon which biologists have based theories of glacial refugia (other than on geological evidence) is a more or less limited distribution of a species or of many species. The locality or area of the distribution is also held as significant. The greater the number of species in an area that have not (yet) been found in other areas, the greater the possibility that the area was a refugium. But the number of known species from an area and the distribution of the species concerned is most often directly proportional to the thoroughness of collecting that has been done.

No area in Canada is as thoroughly collected as the Hazen Camp area. This fact alone would ordinarily bias distribution patterns beyond use for zoogeographic purposes unless some criterion other than taxonomy is used.

I am therefore introducing data from insects and spiders, based on morphology, vagility, and biology, and some geological evidence, to support a suggestion that the northern part of Ellesmere Island had ice free areas during the Wisconsin Glacial division (and perhaps more divisions within the Pleistocene epoch) that served as glacial refugia.

Studies at Hazen Camp have uncovered about 350 species of insects, arachnids and Collembola, including several new species of Homoptera (Richards 1963, 1964a, b), Diptera (Oliver 1963, and pers. comm.), Coleoptera (W. J. Brown, unpubl. and J. A. Downes 1964), Hymenoptera (W. R. M. Mason, pers. comm.), and Acarina (E. Lindquist, pers. comm.). Except for two species of Ichneumonidae that are over five mm long that are scarce, the bulk of the new material from Hazen Camp is small (less than four mm long) and of generally cryptic, unstudied and poorly collected groups.

There are about 75 species of flightless insects in the Hazen Camp area. Most of them are brachypterous and some are apterous. Flightlessness in insects is not a rapidly developed feature, especially in peripheral or marginal regions, where species cannot get the extra energy necessary for morphological experimenting, and where emphasis is on feeding and breeding. I therefore suggest that these flightless insects have been on northern Ellesmere Island for part, if not all, of the Pleistocene epoch. Gressitt (1964, p. 595), in contrary opinion, states that selection favouring loss of wings in insects, particularly Diptera on Campbell Is., (N. Z.), is probably proceeding at a rapid rate. At Hazen Camp, however, no apterous Diptera were found, so either Gressitt's theory is wrong or else the flightless condition develops in insects at different rates in different areas (my inference).

To date, there are 14 species of Collembola and about 80 species of Acarina known from the Hazen Camp area. However, I do not believe that these two groups can be used for refugium analysis as they have the ability to colonize readily in areas where no other arthropod can and they do so very rapidly; the method of this rapid dispersal may be by wind (Gressitt *et al.* 1963, and Gressitt and Collaborators 1964) and by individuals and/or eggs on clods of dirt on birds' feet. Thus there is no way of calculating when these two groups came into an area.

Several species of spiders have probably remained on northern Ellesmere Island during most or all of the Pleistocene epoch. *Tarentula exasperans* was never observed to have a drag line, a feature that might be analogous to flightlessness in insects (H. W. Levi, pers. comm.), and *Pardosa glacialis* and *Xysticus deichmanni* have drag lines that are so weak that they would not support the weight of even a third instar, a feature that might be analogous to brachyptery in insects (my inference).

In contrast, several immatures of *Dictyna borealis* were observed ballooning in early July, 1964. Braendegaard (1937, 1938) has made similar observations in Greenland and elsewhere. The remaining species of spiders, all Linyphiidae, have strong drag lines, indicating possibly recent immigration to the Hazen Camp area.

It appears that there are two basic zoogeographical groups of spiders at Hazen Camp: one group of three species that has withstood the Wisconsin Glaciation and probably most or all of the Pleistocene epoch on northern Ellesmere Island, and a second group that may have moved into the area recently.

The second group, that is, the recent immigrants, appears to have had two sources, one from the arctic zone and the other from the boreal or low arctic zone. Two species of Linyphiidae, *Typhochraestus latithorax* and *Minyriolus pampia* are confined to the night shadow area, and are thus possibly not yet adapted to the arctic light conditions. These night shadow areas are sunny during the day, but shaded during the period that would be night in the temperate regions. The shadow regions are often cooler "at night" than the sunny regions, hence these two species appear to have a diurnal rhythm. On this basis I suggest that these two species are recent immigrants from the temperate or low arctic regions. The remaining species of Linyphiidae are not confined to the night shadow regions. They display full adaptation to the arctic conditions of light. Their general Holarctic distribution indicates this as well.

Taxonomic evidence that the northern end of Ellesmere Island may have been a refugium is based on an analysis of muskoxen skulls by Harington (1964). Gjaerevoll (1963) states that there was a refugium somewhere in the Queen Elizabeth Islands, though he gives neither reasons nor references.

The geological evidence of a refugium on Ellesmere Island is divided. Hattersley-Smith (1961) suggests that any ice that might have been on the plateau between Lake Hazen and Alert was protective rather than erosive, as it is unlikely that the soft silts and lignite would have been preserved in an area where they are in part covered by a piedmont glacier at the present time. On the other hand, widespread erratics have been found in this area, though the date of deposition is not known.

I do not believe that during the Ice Ages of the Pleistocene epoch conditions were ever as severe as most are led to believe. It is fully possible that the conditions were so poor for several years in succession that the ice and snow did not melt off the ground, but equally possible that one season in four or five, or even ten, with favourable conditions melted the ice and snow and permitted life and growth to continue. Thus, even though there were about one and one-half million years in the Pleistocene epoch (Ericson *et al.* 1964), the effective time available for arthropods to have been active may have been as little as three hundred thousand years. If the Pleistocene epoch is shortened to three hundred thousand years as some authors believe it should be, then these animals have had even less time to evolve the flightless condition.

In summary, it appears that there is one fauna on northern Ellesmere Island that has been there since before the Wisconsin Glaciation and perhaps for the duration of the Pleistocene epoch, and another fauna that may have immigrated to northern Ellesmere Island in post-Wisconsin times.

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